1997

Evolutionary Analysis in Law: An Introduction and Application to Child Abuse

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EVOLUTIONARY ANALYSIS IN LAW: AN INTRODUCTION AND APPLICATION TO CHILD ABUSE

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For contemporary biologists, behavior—like physical form—evolves. Although evolutionary processes do not dictate behavior in any inflexible sense, they nonetheless contribute significantly to the prevalence of various behavioral predispositions that, in turn, tend to yield observable patterns of behavior within every known species.

In this Article, Professor Owen D. Jones carefully explores the implications for law of evolved behavioral predispositions in humans, urging both caution and optimism. He first provides an introduction to law-relevant evolutionary biology, assuming no prior knowledge in the subject. He then proposes a model for conducting "evolutionary analysis in law"—by which legal thinkers can locate, assess, and use knowledge about evolutionary influences on human behavior to further the pursuit of many existing social and legal goals. The Article illustrates the operation of that method by showing how it could aid ongoing efforts to understand and curb child abuse. Throughout, Professor Jones emphasizes how the evolutionary perspective on human behavior will typically and usefully supplement, rather than supplant, prevailing notions of the many influences on behavior and the complex interactions among them.

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INTRODUCTION

For centuries, people have used biology to justify political, social, and economic agendas. Some have claimed, in furtherance of discriminatory and even genocidal policies, that biology can segregate fit from unfit, criminal from law-abiding, and worthy from worthless. Today, therefore, mentioning genes and humans in the same sentence properly inspires aggressive vigilance for invidious reductionism, determinism, and divisiveness. Nevertheless, important roles for biology remain—even in law. From forensic medicine to environmental law and from toxic torts to behavioral biology, the study of biological processes deepens our understanding of law's human subject and furthers our efforts to improve through law the conditions of human existence. This Article explores in particular how an understanding of human biology that focuses on evolved human behavioral commonalities, rather than on individual differences, can aid the pursuit of existing social and legal goals.

Popular notions of biological influences on human behavior comprise a patchwork of truths and untruths. While many people today accept, for example, that the human body evolved from ancestors we share with other primates, few know that Darwin's theories extended to behavioral traits, as well as to physical ones—and that behavioral biologists consider these theories essentially correct. Although the modern integration of genetics with the study of processes by which heritable behavioral traits evolve has initiated a profound conceptual reorientation within other human-centered disciplines, such as psychology and anthropology, law lags far behind.[1] Indeed,

1. The synthesis during the 1930s and 1940s of Darwinian natural selection and Mendelian genetics is sometimes known as "neo-Darwinism." For examples of the reorientation this continues to inspire in other disciplines, see David M. Buss, *Evolutionary Psychology: A New Paradigm for Psychological Science*, 6 PSYCHOL. INQUIRY 1 (1995); J. Lawrence Dew et al., *Mating Systems: Anthropologists and Behavioral Ecologists Combine Perspectives*, 3 EVOLUTIONARY ANTHROPOLOGY 111 (1994); John Tooby, *The Emergence of Evolutionary Psychology*, *in* EMERGING SYNTHESES IN SCIENCE 67 (David

more than a century after Darwin's death, the very discipline designed to regulate human behavior often reflects, though perhaps unintendedly, the presupposition that all truly significant law-relevant human behavior is socially constructed.[2] For while law carefully attends to rare circumstances of insanity or perceived genetic or chemical aberrations in individuals, it has devoted insufficient attention to law-relevant behavioral predispositions that are species-wide and emphatically non-aberrational. Law has therefore largely ignored what other disciplines have revealed: Many complex human behaviors that law seeks to regulate, such as those involving aggression, risk-taking, deception, and sexuality, have evolutionary origins in the deep ancestral past—origins that remain relevant today.

Scholars from many disciplines (including a few in law) have tried to impress upon the legal academy the relevance of evolutionary processes in general, and human behavioral evolution in particular, to any sophisticated regulatory regime.[3] The approaches

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Pines ed., 1988). On the emergence of evolutionary psychology generally, see THE ADAPTED MIND: EVOLUTIONARY PSYCHOLOGY AND THE GENERATION OF CULTURE (Jerome H. Barkow et al. eds., 1992) [hereinafter THE ADAPTED MIND]; ROBERT WRIGHT, THE MORAL ANIMAL: EVOLUTIONARY PSYCHOLOGY AND EVERYDAY LIFE (1994).

It is odd that many lawyers remain unaware of the impact of evolution on human behavior when judges and legal scholars so frequently analogize the development of law itself to the process of evolution, *see* E. Donald Elliott, *The Evolutionary Tradition in Jurisprudence*, 85 COLUM. L. REV. 38, 38 (1985) (tracing the traditions in which legal theories have been shaped by analogy to evolution, and observing that the idea that law "evolves" is "so deeply ingrained in Anglo-American legal thought that most lawyers are no longer even conscious of it as a metaphor"); E. Donald Elliott, *Holmes and Evolution: Legal Process as Artificial Intelligence*, 13 J. LEGAL STUD. 113 (1984); Herbert Hovenkamp, *Evolutionary Models in Jurisprudence*, 64 TEX. L. REV. 645 (1985); M.B.W. Sinclair, *Evolution in Law: Second Thoughts*, 71 U. DET. L. REV. 31 (1993) (noting limitations on the use of evolutionary theory in law); M.B.W. Sinclair, *The Use of Evolutionary Theory in Law*, 54 U. DET. MERCY L. REV. 451 (1987) (same), and when debates over the sources of "natural law" have so long occupied legal thinkers, *see, e.g.*, James V. Schall, *The Natural Law Bibliography*, 40 AM. J. JURIS. 157 (1995); Symposium, *Perspectives on Natural Law*, 61 U. CIN. L. REV. 1 (1992).

2. To sociologists, the term "socially constructed" describes behavior that is the product of shared cultural assumptions, rather than any biologically influenced human nature. Although views vary considerably regarding how much of the human behavioral repertoire is socially constructed, even moderate social constructionist positions afford little room for evolved predispositions toward behavior that law might deem significant, holding instead that even those predispositions that may exist are filtered, stabilized, and systematized through a social context that overwhelmingly determines their manifestation. I am thankful to Mark Suchman, Department of Sociology, University of Wisconsin, for helpful discussion of this point. The extent to which "nurture *versus* nature" dichotomies may sometimes mislead is explored *infra* notes 105-07 and accompanying text.

3. *See, e.g.*, RICHARD D. ALEXANDER, THE BIOLOGY OF MORAL SYSTEMS (1987); RICHARD D. ALEXANDER, DARWINISM AND HUMAN AFFAIRS (1979) [hereinafter ALEXANDER, DARWINISM AND HUMAN AFFAIRS]; JOHN H. BECKSTROM, DARWINISM

APPLIED: EVOLUTIONARY PATHS TO SOCIAL GOALS (1993) [hereinafter BECKSTROM, DARWINISM APPLIED]; JOHN H. BECKSTROM, EVOLUTIONARY JURISPRUDENCE: PROSPECTS AND LIMITATIONS ON THE USE OF MODERN DARWINISM THROUGHOUT THE LEGAL PROCESS (1989); JOHN H. BECKSTROM, SOCIOBIOLOGY AND THE LAW: THE BIOLOGY OF ALTRUISM IN THE COURTROOM OF THE FUTURE (1985) [hereinafter BECKSTROM, SOCIOBIOLOGY AND THE LAW]; BIOLOGY, CULTURE, AND ENVIRONMENTAL LAW (Michael T. McGuire & Manfred Rehbinder eds., 1993); ROBERT H. FRANK, PASSIONS WITHIN REASON: THE STRATEGIC ROLE OF THE EMOTIONS (1988); OLIVER GOODENOUGH, PRIVACY AND PUBLICITY: SOCIETY, DOCTRINE, AND THE DEVELOPMENT OF LAW 11-19 (1996); MARGARET GRUTER, LAW AND THE MIND: BIOLOGICAL ORIGINS OF HUMAN BEHAVIOR (1991) [hereinafter GRUTER, LAW AND THE MIND]; JACK HIRSHLEIFER, ECONOMIC BEHAVIOUR IN ADVERSITY (1987); HUMAN NATURE AND THE NEW EUROPE (Michael T. McGuire ed., 1993); LAW, BIOLOGY & CULTURE: THE EVOLUTION OF LAW (Margaret Gruter & Paul Bohannan eds., 1983) [hereinafter LAW, BIOLOGY & CULTURE]; ROGER D. MASTERS, BEYOND RELATIVISM: SCIENCE AND HUMAN VALUES (1993); ROGER D. MASTERS, THE NATURE OF POLITICS (1989); THE NEUROTRANSMITTER REVOLUTION: SEROTONIN, SOCIAL BEHAVIOR, AND THE LAW (Roger D. Masters & Michael T. McGuire eds., 1993); OSTRACISM: A SOCIAL AND BIOLOGICAL PHENOMENON (Margaret Gruter & Roger D. Masters eds., 1986) [hereinafter OSTRACISM]; RICHARD A. POSNER, SEX AND REASON (1992); THE SENSE OF JUSTICE: BIOLOGICAL FOUNDATIONS OF LAW (Roger D. Masters & Margaret Gruter eds., 1992); Richard D. Alexander, *Natural Selection and Societal Laws*, *in* MORALS, SCIENCE, AND SOCIALITY 249 (H. Tristram Engelhardt, Jr. & Daniel Callahan eds., 1978); John H. Beckstrom, *The Potential Dangers and Benefits of Introducing Sociobiology to Lawyers*, 79 NW. U. L. REV. 1279 (1985); Kingsley R. Browne, *Biology, Equality, and the Law: The Legal Significance of Biological Sex Differences*, 38 SW. L.J. 617 (1984); Kingsley R. Browne, *Sex and Temperament in Modern Society: A Darwinian View of the Glass Ceiling and the Gender Gap*, 37 ARIZ. L. REV. 971 (1995) [hereinafter Browne, *Sex and Temperament*]; Robert D. Cooter, *Structural Adjudication and the New Law Merchant: A Model of Decentralized Law*, 14 INT'L REV. L. & ECON. 215 (1994); E. Donald Elliott, *Law and Biology: The New Synthesis?*, 41 ST. LOUIS U. L.J. (Fall 1997) (forthcoming); E. Donald Elliott et al., *Toward a Theory of Statutory Evolution: The Federalization of Environmental Law*, 1 J.L. ECON. & ORG. 313 (1985); Wolfgang Fikentscher & Michael T. McGuire, *A Four-Function Theory of Biology for Law*, 25 RECHTSTHEORIE 291 (1994); Lawrence A. Frolik, *The Biological Roots of the Undue Influence Doctrine: What's Love Got to Do with It?*, 57 U. PITT. L. REV. 841 (1996); Suzanne Gibson, *Law Representing Life—Reflections on Darwinian Jurisprudence*, 3 LAW & CRITIQUE 99 (1992); Oliver R. Goodenough, *Mind Viruses: Culture, Evolution and the Puzzle of Altruism*, 34 SOC. SCI. INFO. 287 (1995) [hereinafter Goodenough, *Mind Viruses*]; Margaret Gruter, *Law in Sociobiological Perspective*, 5 FLA. ST. U. L. REV. 181 (1977); Margaret Gruter, *The Origins of Legal Behavior*, 2 J. SOC. & BIOLOGICAL STRUCTURES 43 (1979); Owen D. Jones, *Genes, Behavior, and Law*, 15 POL. & LIFE SCI. 101 (1996) [hereinafter Jones, *Genes, Behavior, and Law*]; Owen D. Jones, *Law and Evolutionary Biology: Obstacles and Opportunities*, 10 J. CONTEMP. HEALTH L. & POL'Y 265 (1994); Owen D. Jones, *Reproductive Autonomy and Evolutionary Biology: A Regulatory Framework for Trait-Selection Technologies*, 19 AM. J.L. & MED. 187 (1993) [hereinafter Jones, *Reproductive Autonomy and Evolutionary Biology*]; John O. McGinnis, *The Once and Future Property-Based Vision of the First Amendment*, 63 U. CHI. L. REV. 49 (1996); John O. McGinnis, *The Original Constitution and Our Origins*, 19 HARV. J.L. & PUB. POL'Y 251 (1996); William H. Rodgers, Jr., *Bringing People Back: Toward a Comprehensive Theory of Taking in Natural Resources Law*, 10 ECOLOGY L.Q. 205 (1982) [hereinafter Rodgers, *Bringing People Back*]; William H. Rodgers, Jr., *Deception, Self-Deception, and Mythology: The Law of Salmon in the Pacific Northwest*, 26 PAC. L.J. 821 (1995); William H. Rodgers, Jr., *The Evolution of Cooperation in Natural Resources*

they espouse reflect the growing recognition that an evolutionary perspective can usefully illuminate the origins of particular kinds of behavior that law seeks to regulate,[4] of basic moral intuitions,[5] and of proto-legal behaviors (such as ostracism).[6] Sometimes the perspective will be relevant at doctrinal or case levels.[7] Other times it may provide important policy-relevant insights about the social and politi-

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Law: The Drifter/Habitué Distinction, 38 U. FLA. L. REV. 195 (1986); William H. Rodgers, Jr., *The Lesson of the Owl and the Crows: The Role of Deception in the Evolution of the Environmental Statutes,* 4 J. LAND USE & ENVTL. L. 377 (1989); William H. Rodgers, Jr., *The Lesson of the Red Squirrel: Consensus and Betrayal in the Environmental Statutes,* 5 J. CONTEMP. HEALTH L. & POL'Y 161 (1988); William H. Rodgers, Jr., *Where Environmental Law and Biology Meet: Of Pandas' Thumbs, Statutory Sleepers, and Effective Law,* 65 U. COLO. L. REV. 25 (1993); Jeffrey E. Stake, *Darwin, Donations, and the Illusion of Dead Hand Control,* 64 TUL. L. REV. 705 (1990); Symposium, *Behavior, Evolution and the Sense of Justice,* 34 AM. BEHAV. SCIENTIST 283 (1991); Lionel Tiger, *The Possible Biological Origins of Sexual Discrimination,* 20 IMPACT SCI. ON SOC'Y 29 (1970); Amy L. Wax, *Against Nature—On Robert Wright's* The Moral Animal, 63 U. CHI. L. REV. 307 (1996); Margo Wilson, *Impact of the Uncertainty of Paternity on Family Law,* 45 U. TORONTO FAC. L. REV. 216 (1987); articles collected in volume 8 of the JOURNAL OF CONTEMPORARY LEGAL ISSUES (devoted to Law, Human Behavior, and Evolutionary Biology) (forthcoming) and volume 22 of the VERMONT LAW REVIEW (devoted to Biology, Behavior, and Criminal Law) (forthcoming Dec. 1997); sources cited *supra* note 1. On the related relevance of applying complex adaptive systems theory to legal processes, see Mark J. Roe, *Chaos and Evolution in Law and Economics,* 109 HARV. L. REV. 641 (1996); J.B. Ruhl, *Complexity Theory as a Paradigm for the Dynamical Law-and-Society System: A Wake-Up Call for Legal Reductionism and the Modern Administrative State,* 45 DUKE L.J. 849 (1996); J.B. Ruhl, *The Fitness of Law: Using Complexity Theory to Describe the Evolution of Law and Society and Its Practical Meaning for Democracy,* 49 VAND. L. REV. 1407 (1996); Peter Strahlendorf, *Evolutionary Jurisprudence: Darwinian Theory in Juridical Science* (1991) (unpublished S.J.D. thesis) (University of Toronto, on file with author) [hereinafter Strahlendorf, *Evolutionary Jurisprudence*].

4. *See, e.g.*, Paul Bohannan, *Some Bases of Aggression and Their Relationship to Law, in* LAW, BIOLOGY & CULTURE, *supra* note 3, at 147.

5. *See, e.g.*, FRANS DE WAAL, GOOD NATURED: THE ORIGINS OF RIGHT AND WRONG IN HUMANS AND OTHER ANIMALS (1996); ROGER D. MASTERS, BEYOND RELATIVISM: SCIENCE AND HUMAN VALUES (1993); JEFFRIE G. MURPHY, EVOLUTION, MORALITY, AND THE MEANING OF LIFE (1982); JAMES Q. WILSON, THE MORAL SENSE (1993); Richard D. Alexander, *Biology and the Moral Paradoxes, in* LAW, BIOLOGY & CULTURE, *supra* note 3, at 101; Christopher Boehm, *The Evolutionary Development of Morality as an Effect of Dominance Behavior and Conflict Interference, in* LAW, BIOLOGY & CULTURE, *supra* note 3, at 134; Richard A. Epstein, *The Utilitarian Foundations of Natural Law,* 12 HARV. J.L. & PUB. POL'Y 713 (1989); Wax, *supra* note 3.

6. *See, e.g.*, OSTRACISM, *supra* note 3; Donald T. Campbell, *Legal and Primary-Group Social Controls, in* LAW, BIOLOGY & CULTURE, *supra* note 3, at 159; Jane Goodall, *Order Without Law, in* LAW, BIOLOGY & CULTURE, *supra* note 3, at 50.

7. *See, e.g.*, Browne, *Sex and Temperament, supra* note 3 (arguing that in certain employment contexts the sexes may tend to separate themselves according to sex-specific evolved psychologies, and that one should therefore not assume in employment discrimination cases that the *entire* statistical difference in representation between the sexes is the product of traditionally conceived, invidious discrimination).

cal ordering of humans,[8] or may facilitate predicting the instrumental effects of different laws[9] and the relative resistance humans may present to certain efforts to direct or constrain their behavior.[10] This attention to evolved human behavioral predispositions will have much to contribute, for example, to the fields of family law, criminal law, environmental law, property law, and privacy law.[11] For while biology typically supplies no independent content to policies themselves, it can significantly contribute to that body of knowledge that helps us to pursue the policies we set.

To date, legal literature has lacked an extended discussion of precisely how, *methodologically*, legal academics and other policymakers might usefully integrate into law knowledge of the evolutionary processes that science uncovers. This Article undertakes to remedy this absence by proposing and demonstrating a method by which law can, without losing its normative center, reorient itself to take account of evolutionary influences on law-relevant behavior. This is the basic logic: Evolutionary processes influence the physical and behavioral traits of every organism. Understanding how and why these processes operate as they do helps us to identify factors that influence the probability that organisms will manifest particular patterns of behaviors in response to various environmental stimuli. Because a (perhaps *the*) fundamental purpose of law is to regulate human social behaviors, understanding the evolutionary influences upon the development of some of those behaviors will necessarily assist any sound and practical legal enterprise. What might be called "evolutionary analysis in law" will prove a valuable tool to those charged with maintaining an equitable, safe, and orderly society through the machinery of law.

Many resist this logic. Recent attempts to explain the functions in law that an evolutionary analysis might serve have thus far been

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8. *See, e.g.*, ROGER D. MASTERS, THE NATURE OF POLITICS (1989); FRANS DE WAAL, CHIMPANZEE POLITICS: POWER AND SEX AMONG APES (1982); FRANS DE WAAL, PEACEMAKING AMONG PRIMATES (1989); Roger D. Masters, *Evolutionary Biology, Political Theory and the State*, *in* LAW, BIOLOGY & CULTURE, *supra* note 3, at 171.

9. *See* Richard D. Schwartz, *On the Prospects of Using Sociobiology in Shaping the Law: A Cautionary Note*, *in* LAW, BIOLOGY & CULTURE, *supra* note 3, at 15, 22-23.

10. *See, e.g.*, GRUTER, LAW AND THE MIND, *supra* note 3, at 14-15, 21, 36 (stressing that legislators should be aware of biological propensities and constraints in the human behavioral makeup); Fikentscher & McGuire, *supra* note 3, at 300-10 (developing the ideas of "Constraining" functions and "Liberating" functions).

11. *See, e.g.*, GRUTER, LAW AND THE MIND, *supra* note 3, at 71-142; Richard D. Alexander, *Biology and Law*, 7 ETHOLOGY & SOCIOBIOLOGY 167 (1986); Rodgers, *Bringing People Back*, *supra* note 3.

met with either stubborn denial that evolutionary processes continue to importantly influence human behavior, with fear that behavioral biology must inevitably inspire evil uses, or with pragmatic skepticism about *precisely how* evolutionary insights might usefully inform our legal system. Consequently, Part I of this Article explains in non-technical terms the fundamental, scientifically well-accepted, and often counter-intuitive principles of evolutionary biology essential to a properly contextualized discussion of human behavior. It therefore offers an integrated framework for understanding behavioral biology, confronts widespread misperceptions of human evolution, and summarizes the essential theories and findings that those who think about law need to know.

Part II builds upon Part I to introduce and develop a concrete four-stage model for using evolutionary analysis to serve societal goals. It demonstrates the model's utility in detail, showing how it can inform and significantly aid efforts to address tough legal problems, such as the prevalence of child abuse. The Article concludes that evolutionary analysis is an exceptionally powerful but easily misunderstood tool for legal policymakers. Carefully handled, it can serve to: 1) refine behavioral models; 2) generate new legal strategies for regulating behaviors; 3) improve the cost-benefit analyses by which society often prioritizes social and legal goals; and 4) suggest important and promising new areas of research.

I am well aware that discussions about the evolution of human psychology and behavior can become extremely volatile.[12] Incorrect assumptions, sparked by insufficient explanations, can yield the kinds of misunderstandings likely to polarize parties and galvanize hostilities. It is therefore important to make clear, at the outset, what this Article does not say.

This Article does *not* suggest that genes "determine" specific human behavior.[13] They do not. It does *not* suggest that an evolu-

12. *See, e.g.*, Symposium, *Genetics and Crime*, 15 POL. & LIFE SCI. 83-110 (1996) (collecting participant reactions to conference exploring possible influences of biology on the incidence of certain proscribed behaviors); David L. Wheeler, *An Escalating Debate over Research that Links Biology and Human Behavior*, CHRON. HIGHER EDUC., June 24, 1992, at A7.

13. I fully agree with Professors Dreyfuss and Nelkin that we must carefully avoid "genetic essentialism," which might inappropriately be used to justify reorientation of particular social policies. Rochelle Cooper Dreyfuss & Dorothy Nelkin, *The Jurisprudence of Genetics*, 45 VAND. L. REV. 313, 338 (1992). While I share their concerns over the frequent misuses and misunderstandings of biology, however, this Article explores how one may usefully acknowledge human behavioral predispositions in ways that are *not* genetically deterministic.

tionary approach to any human affair should be dispositive of any legal or other issue whatsoever. It should not. *Nor* does the Article suggest that an evolutionary analysis is the most important analysis, or that it should displace other analyses that it might more usefully supplement or complement. Instead, this Article argues that understanding the processes by which some of our diverse human behaviors evolved *will inevitably further whatever social and legal goals we pursue that address those behaviors.* That is: More knowledge is better than less knowledge. Far from over-simplifying human behavior, evolutionary analysis will vindicate, more fully than may currently unsupplemented behavioral models, our species' unique history, consciousness, capabilities, and richly complex behavioral processes.

I. A PRIMER IN LAW-RELEVANT EVOLUTIONARY BIOLOGY

Understanding the relevance of behavioral biology to concrete legal and policy questions requires some facility in evolutionary theory.[14] Because few lawyers have formal scientific training, and

14. Theories to explain phenomena come in two kinds: *supernatural* theories, which posit unknowable forces operating outside the principles that apparently govern the observable world, and which are therefore incapable of being tested or disproved, and *natural* theories, the predictive hypotheses of which are potentially vulnerable to disproof. For many scholars, and indeed for our legal system, this "testability" separates science from religion. *See* CARL G. HEMPEL, PHILOSOPHY OF NATURAL SCIENCE (1966); KARL R. POPPER, CONJECTURES AND REFUTATIONS: THE GROWTH OF SCIENTIFIC KNOWLEDGE 37 (5th ed. 1989) (stating that "the criterion of the scientific status of a theory is its falsifiability, or refutability, or testability") (quoted favorably in Daubert v. Merrell Dow Pharm. Inc., 509 U.S. 579, 593 (1993)); KARL R. POPPER, THE LOGIC OF SCIENTIFIC DISCOVERY (1959). At the moment, the theory of evolution by natural selection is the only natural theory that explains both the physical and behavioral characteristics of life. It is extremely robust and powerfully in accord with empirical research. The reasons to prefer natural to supernatural explanations for nature's puzzles have been and will continue to be debated elsewhere and are beyond the scope of this Article. *Compare* PHILLIP E. JOHNSON, DARWIN ON TRIAL (1991) (arguing against naturalistic hypotheses), *and* THE CREATION HYPOTHESIS: SCIENTIFIC EVIDENCE FOR AN INTELLIGENT DESIGNER (J.P. Moreland ed., 1994) (same), *with* RICHARD DAWKINS, THE BLIND WATCHMAKER (1986) (defending naturalistic hypotheses), *and* DOUGLAS J. FUTUYMA, SCIENCE ON TRIAL: THE CASE FOR EVOLUTION (1983) (same). Here we will simply adopt the conventional preference for natural theories and proceed directly to explore evolutionary explanations for the origins and persistence of some observable behaviors.

Quibbles on the margin about the specifics of evolution, such as the appropriate significance, if any, to evolutionary theory of "punctuated equilibrium" or the so called "new" group selectionism, should not be confused with fundamentally different paradigms explaining how and why life looks and behaves as it does. *Compare* S.J. Gould & R.C. Lewontin, *The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme*, B205 PROCEEDINGS ROYAL SOCIETY LONDON 581 (1979)

because the theoretical and empirical landscape of biology has changed so dramatically in the last two decades, this Part provides a non-technical, panoramic survey of the current and fundamental principles necessary to make or follow evolutionary analysis in law. While it is unnecessary to master every detail of evolutionary theory to follow the subsequent logic in Part II, a "big picture" perspective will help to reveal both the thematic coherence and the deep synergy of evolutionary biology's patterns and make obvious its utility to law.

Admittedly, this takes time. And were it possible to plunge directly into discussion of the model in Part II, and of the child abuse analysis that demonstrates it, I would do so. For there lies some fascinating (if often gruesome) material that stands as a testament to man's (and often woman's) creative cruelty and heartless violence. Like an economic analysis that preceded a foundation in basic economic principles, however, that would be premature.

A. Preparatory Remarks: Law and Biology on Causation

Law and biology overlap in their preoccupations with "causation." The term has different meanings, however, within each discipline and it is critical to keep these meanings in mind. While lawyers parse distinctions between proximate causes, remote causes, concurrent causes, contributory causes, intervening causes, and "but for" causes of phenomena,[15] behavioral biologists draw a single but crucial distinction between "proximate" causes and "ultimate" causes.[16] The seeming familiarity to lawyers of these last two terms is misleading, because they are terms of art—with meanings in biology quite different from any that lawyers might impute to them.[17]

In biology, the term "proximate cause" refers only to the "how" of behavior. It peacefully coexists with the term "ultimate cause,"

(laying important groundwork for "punctuated equilibrium"), *with* DAWKINS, *supra*, at 223-52 (arguing for "puncturing punctuationism"); and compare David Sloan Wilson & Elliott Sober, *Reintroducing Group Selection to the Human Behavioral Sciences*, 17 BEHAV. & BRAIN SCI. 585, 598-605 (1994) with the collected commentaries that immediately follow it.

15. *See, e.g.*, H.L.A. HART & TONY HONORE, CAUSATION IN THE LAW (2d ed. 1985).

16. On proximate and ultimate causation generally, see JOHN ALCOCK, ANIMAL BEHAVIOR: AN EVOLUTIONARY APPROACH 2-6 (5th ed. 1993); TIMOTHY H. GOLDSMITH, THE BIOLOGICAL ROOTS OF HUMAN NATURE: FORGING LINKS BETWEEN EVOLUTION AND BEHAVIOR 3-11, 46-69 (1991); John Alcock & Paul Sherman, *The Utility of the Proximate-Ultimate Dichotomy in Ethology*, 96 ETHOLOGY 58 (1994); Bobbi S. Low, *Human Sex Differences in Behavioral Ecological Perspective*, 16 ANALYSE & KRITIK 38, 40-42 (1994).

17. *See* Jones, *Genes, Behavior, and Law*, *supra* note 3, at 101.

which describes the larger "why" of behavior. More precisely, "proximate causes" describe immediate causes, related to the internal mechanisms and development that cause an organism to manifest a particular behavior. They may be defined in terms of physiology and biochemistry, for example, as well as, at times, an organism's unique developmental-environmental history.[18] "Ultimate causes," on the other hand, describe evolutionary processes by which the same behavior came to be commonly observable.[19] These may be defined in terms of the history and reproductive consequences of behavior. Proximate and ultimate causes operate together, with all behavior depending on ultimately-shaped proximate mechanisms.[20]

To clarify, suppose one were to ask why a male robin sings. One answer would be: "Because hormonal changes triggered by the lengthening of successive days cause the robin to force air over appropriately shaped vocal chords." But this answer, using terms of *proximate* causation, leaves many questions unanswered. It does not explain, for instance, why it came to pass that lengthening days instead of shortening ones spark these hormonal changes instead of others, or why it came to be that these particular hormonal changes cause *singing* rather than, for example, one-legged hopping. These questions concern the historical origins of currently manifested gene combinations, and thus require an inquiry into ultimate causation. The *ultimate* cause of singing behavior, evolutionary analysis reveals, reflects the fact that the remote ancestors of today's singing males—through their singing—claimed territory, attracted mates, and left more offspring than did contemporaries not predisposed to sing. To the extent that the ability to sing and the urge to respond to certain environmental cues with singing were influenced by heritable predispositions, the proportion of male robins in successive generations that sang inevitably increased over time until we now observe the trait to be typical of males of the species.

In the same fashion, many behaviors—including many human behaviors—are most completely understood in terms of proximate and ultimate causes. That is, when people exhibit law-relevant behaviors, there are often two very different kinds of causes operating simultaneously. What follows offers a way to understand the inseparability of proximate *and* ultimate causes, and thereby to better

18. *See* GOLDSMITH, *supra* note 16, at 6-11.

19. *See* ALCOCK, *supra* note 16, at 2-6; GOLDSMITH, *supra* note 16, at 6-11.

20. Indeed, as Goldsmith puts it: "Nothing of importance in biology can be said to have but a single cause." GOLDSMITH, *supra* note 16, at 8.

understand the complex process by which law-relevant behaviors emerge.

B. *The Evolutionary Perspective: On the Making of Ancestors*

Like some of the world's most complex games, evolution takes a minute to learn and a lifetime to master. Its basic contours seem vaguely familiar, but its details are "fractal-ed" into micro-landscapes rich with detail and subtlety. Fortunately, understanding evolutionary processes sufficiently to see their relevance to the legal enterprise requires working knowledge of only a few foundational concepts. I believe that the simplest way for lawyers to organize and understand these concepts is to put them into the framework of a metaphorical game—a game that *all living organisms are forced to play*, simply by virtue of certain necessary correlates to reproducing in a world of limited resources.

This game, like every game, has:

1) a duration;
2) an objective;
3) rules of play;
4) attendant strategies; and
5) inherent opportunities for conflict and cooperation.

What follows considers these in sequence.

1. The Duration of the Game: The Clock of Evolution

Existing evidence indicates that the Earth formed roughly 4.5 billion years ago.[21] The game of evolution started when life first emerged a little more than half of one billion years later,[22] and will play on so long as any life continues. Along the way, organismic contestants and the genes[23] they carry typically appear briefly and then disappear into extinction. Indeed, scientists estimate that 99.9% of all species that have ever lived are now extinct.[24] (For the carried genes, we'll call this "losing.") In order to understand how humans have fared in this game, it is absolutely essential to understand evolutionary time. Lacking this, absolutely everything—from the incremental evolution of the eye from light-sensitive cells to the rele-

21. *See* Lawrence Badash, *The Age-of-the-Earth Debate*, SCI. AM., Aug. 1989, at 90, 90.

22. *See* EDWARD O. WILSON, THE DIVERSITY OF LIFE 186 (1992).

23. Genes are faithfully replicating units that encode information necessary for constructing the principal building blocks (proteins) of all living organisms.

24. *See* DAVID M. RAUP, EXTINCTION: BAD GENES OR BAD LUCK? 3-4 (1991).

vance of evolutionary biology for legal enterprises—will seem utterly implausible.

These are current estimates of the game-time leading to modern humans. Early organisms were singled-celled and lacked central nuclei for about two billion years.[25] Between the first microscopic, nucleated organisms and the first known vertebrate fish, more than another billion years elapsed.[26] The next 100 million years saw the evolution of amphibians, early reptiles, and early land arthropods (like millipedes),[27] while the 100 million years after that brought the early dinosaurs and mammals.[28] From this point, it still took more than an additional 100 million years before the first tiny primates appeared.[29]

After nearly fifty million years of ensuing early primate history, the ancestors we share with today's orangutans, gorillas, and chimpanzees branched from the ancestors of what we now call the monkeys.[30] Thirteen million years later, the ancestors we share with gorillas, chimpanzees, and bonobos then branched from the ancestors of today's orangutans.[31] Our own hominid ancestors subsequently diverged from the ancestors of gorillas, chimps, and bonobos about three million years later,[32] with the first *Homo* (*Homo habilis*) appearing nearly five million years after that.[33] Although archaic forms of *Homo sapiens* emerged after roughly two million years more (and remain the subject of continuing anthropological debate) the so-called modern humans—*Homo sapiens sapiens*—seem not to have appeared for yet another 200,000 years.[34] Nevertheless, it was still roughly an additional 70,000 years before our own subspecies of *Homo sapiens*, which we imagine when we think of ourselves, had apparently displaced our competing subspecies, *Homo sapiens nean-*

25. *See* WILSON, *supra* note 22, at 186.

26. *See* RICHARD COWAN, HISTORY OF LIFE 126 (2d ed. 1995).

27. *See id.* at 30-179.

28. *See id.* at 201-92.

29. *See id.* at 390.

30. *See* DE WAAL, *supra* note 5, at 4.

31. *See id.*

32. *See id.*

33. *See* COWAN, *supra* note 26, at 410. Early Homo recently has been dated to 2.33 million years ago. *See* John Noble Wilford, *2.3-Million-Year-Old Jaw Extends Human Family*, N. Y. TIMES, Nov. 19, 1996, at A1.

34. *See* COWAN, *supra* note 26, at 417-18; *see also* CAMBRIDGE ENCYCLOPEDIA OF HUMAN EVOLUTION 241-51 (S. Jones et al. eds., 1992). On continuing debates about dating and classifying ancestral hominids, see Nancy Minugh-Purvis, *The Modern Human Origins Controversy: 1984-1994*, *in* 4 EVOLUTIONARY ANTHROPOLOGY 140 (1995).

derthalensis, causing the latter's extinction.[35]

Looking back, then, we see the first *Homo* roughly two million years ago, archaic *Homo sapiens* 300,000 years ago, our own subspecies of *Homo sapiens* roughly 100,000 years ago, and post-neanderthal human existence a mere 35,000 years ago. To put the remaining time in perspective, scholars currently believe that members of our species remained hunter-gatherers until merely 10,000 to 15,000 years ago, at which time they started shifting to an agricultural-pastoral existence, the efficiencies of which provided much of the energy for the explosion in technological development.[36] Non-pictographic human writing appeared only 5000 years ago,[37] and the celebrated Hammurabi Code, one of the earliest known written legal systems, appeared only about 3700 years ago.[38]

In short, if the history of life on Earth were condensed into a period of seven days, the time elapsed since the year 1 A.D. would constitute barely 1/3 of a second. We are therefore, in fact, fully *thirty-five thousand times* as far from our first primate ancestor as we are from year 1 A.D. And the length of time our primate ancestors were the *same* creatures that gave rise to the gorillas, chimpanzees, and bonobos (roughly sixty-three million years) is *six-hundred-and-thirty times* as long as the period during which we have existed as our own, modern species—and more than *thirty-one thousand times* as long as the time elapsing since year 1 A.D. As will be seen below, during all this time evolutionary processes sifted the precursors of genetically influenced human behaviors, as our ancestors played the game we continue to play.

35. *See* COWAN, *supra* note 26, at 419-21; *see also* IAN TATTERSALL, THE FOSSIL TRAIL: HOW WE KNOW WHAT WE THINK WE KNOW ABOUT HUMAN EVOLUTION 229-46 (1995); IAN TATTERSALL, THE LAST NEANDERTHAL: THE RISE, SUCCESS, AND MYSTERIOUS EXTINCTION OF OUR CLOSEST RELATIVES 174-99 (1995).

36. *See* FUTUYMA, *supra* note 14, at 110-13.

37. *See* ALBERTINE GAUR, THE HISTORY OF WRITING 17 (1984); THE MAINSTREAM OF CIVILIZATION TO 1715, at 6-9 (Stanley Chodorow ed., 5th ed. 1989).

38. *See* Richard S. Ellis, *Code of Hammurabi*, *in* 13 THE ENCYCLOPEDIA AMERICANA 750, 750 (1996). The Hammurabi Code is no longer the earliest known written legal system, although among the early systems it is the most famous. *See id.*

Selected Developments in Life History*

Years Ago	Development	Years Elapsed
4,500,000,000	Earth Forms	N/A
3,900,000,000	Life Appears	600,000,000
1,800,000,000	Nucleated Organisms	2,100,000,000
460,000,000	Vertebrate Fish	1,340,000,000
360,000,000	Arthropods, Amphibians, Reptiles	100,000,000
210,000,000	Dinosaurs, Early Mammals	150,000,000
70,000,000	Early Primates	140,000,000
23,000,000	*Homo* Ancestors Branch from Monkeys	47,000,000
10,000,000	*Homo* Ancestors Branch from Orangutans	13,000,000
7,000,000	*Homo* Ancestors Branch from Gorillas, Chimps, Bonobos	3,000,000
2,300,000	Earliest *Homo*	4,700,000
300,000	Archaic *Homo sapiens*	2,000,000
100,000	Skeletally Modern *Homo sapiens sapiens*	200,000
35,000	*Homo sapiens neanderthalis* Extinct; Modern Humans	65,000
13,000	Human Agriculture	22,000
5,000	Human Writing	8,000
3,700	Written Law	1,300
2,000	Start of Modern Calendar	1,700

*Dates are quite approximate, and likely to change with new findings

2. The Objective of the Game: Persistence of Existence

a. Getting Ahead: Reproductive Success

The objective of the evolutionary game is to have equal or greater "reproductive success" ("RS") than other members of one's species.[39] Yet because increases in RS tend to yield geometric increases in a species' population size at the same time that exploitable resources of the world are ultimately finite, the evolutionary game is inherently competitive.[40]

39. The term "reproductive success" is often used in the narrow sense of "direct fitness" (which includes genes replicated only in direct descendants) and is often distinguished from "indirect fitness" (which includes the genes replicated indirectly by increasing the reproduction of non-descendent kin). *See* ALCOCK, *supra* note 16, at 576, 578; *see also infra* text accompanying notes 43-47 (discussing "inclusive fitness"). To avoid confusion, reproductive success is used here in the broader sense also common in ethological literature. *See, e.g.*, Paul Turke & L.L. Betzig, *Those Who Can Do: Wealth, Status, and Reproductive Success on Ifaluk*, 6 ETHOLOGY & SOCIOBIOLOGY 79, 79 (1985) ("Modern Darwinian theory predicts that human behavior will be adaptive, that is, designed to promote maximum reproductive success (RS) through available *descendent and nondescendent... relatives*." (emphasis added)).

40. As economist Jack Hirshleifer has observed, Darwin's ideas are consistent with universal economic laws: The patterns of social organization "are the product of scarcity of resources, of the limited availabilities of materials and energy in the face of the unlim-

Although reproductive success is the only thing in the end that matters in evolution, that proposition often proves difficult to sell outside biology circles. Defining "success" in such a seemingly arbitrary and mechanistic way appears to slight other important qualities that might serve as alternative definitions of success—such as extraordinary (but *non*-reproductive) physical prowess or, in the human context, such things as capacity to love, artistic talent, economic wealth, or political achievement. Yet while different definitions of success apply in different contexts, one must at least initially focus on reproductive success, as opposed to other perhaps more laudable virtues, whenever seeking to understand why organisms, in any particular slice of time, tend to look and behave as they do.

To see this, imagine time divided into discrete slices, with each slice containing creatures of different shapes, sizes, and behaviors. Only the *characteristics* of organisms, not the organisms themselves, can flow smoothly through time; only a few characteristics will reappear in slice after slice, as if in successive frames of a lengthy motion picture. Attention to reproductive success is important, therefore, whenever we are more interested in characteristics that exist in more than one slice of time than we are in characteristics that may flash in one, momentarily, and disappear.[41] The characteristics of individuals that are reproductively successful are simply far more likely to appear in any later generation than are characteristics of individuals that were not reproductively successful.[42] Thus, the word "success," which at first seems so susceptible of individually-ascribed meaning, is as objectively measurable *in the biological context* as are the relatively unmalleable concepts of "existence" and "persistence."

b. Keeping Score: Inclusive Fitness

Until relatively recently, biologists kept score in the game of evolution by counting the number of an individual's offspring that

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ited expansive tendency of life." J. Hirshleifer, *Natural Economy Versus Political Economy*, 1 J. SOC. & BIOLOGICAL STRUCTURES 319, 337 (1978).

41. Even heritable characteristics are unlikely to become prevalent in subsequent populations unless they generally contribute to RS (in even the smallest of ways) or manage to free-ride with characteristics that do.

42. In other words, one thing we know for certain is that every creature, at every moment, is the product of ancestors traceable back in time, frame by frame. Yet not every creature will itself become an ancestor. Only the heritable physical and behavioral characteristics of ancestors stand a chance of being replicated into successive generations and of traveling down through time to that slice of time we happen to be studying. *See generally* RICHARD DAWKINS, RIVER OUT OF EDEN: A DARWINIAN VIEW OF LIFE 1-29 (1995) (highlighting evolutionary significance of ancestors with metaphor comparing genetically influenced traits to a digital river, flowing through time).

survived and reproduced. But this measure ignored one critical fact: Offspring are not the only genetic relatives an individual has. To the extent that other relatives also share genes with an individual, *their* reproductive success *also* contributes to the individual's reproductive success. Each parent in a sexually reproducing species contributes 1/2 of the genetic complement of each offspring, so every individual is, on average, equally related (by 1/2) to its own parents, offspring, and siblings (the latter of which typically receive a different combination of maternal and paternal genes). An individual is therefore also equally related to the offspring of these three groups (by 1/4, since 1/2 x 1/2 = 1/4). Put another way, since an offspring shares 1/2 of its genes with each of its parents, an offspring will on average share through each parent 1/4 of its genes with each of that parent's siblings, 1/8 of its genes with the offspring of its parent's siblings (its "cousins"), and so forth.[43] The average fraction of genes shared with a given relative can thus be calculated by the degree of consanguinity.[44]

The important thing to know, from this, is that while offspring were once commonly thought to be the only currency of reproductive success, they are now recognized to be only a subset of the relatives capable of transferring some of an individual's genetic complement into future populations. Reproductive success, therefore, cannot be calculated in offspring alone. Rather, one needs to take stock of the extent to which an individual has increased the reproductive success of its relatives (discounted by their degree of relatedness). This cu-

43. This common phrasing oversimplifies by convention. Technically, members of a species already share most of their genes in common. *See* ROBERT TRIVERS, SOCIAL EVOLUTION 126 (1985). Moreover, the term "gene" often refers to a locus on a chromosome that codes for a trait-affecting protein, but in the inclusive fitness context "gene" is also shorthand for "allele," which is a term for each alternative *version* of a gene that may occur at a single locus. *See id.* at 126-28.

44. Biologists term this the "coefficient of relatedness." *See id.* Classics on "kin selection," which yields behavior acutely sensitive to differing degrees of relatedness, include Mary Jane West Eberhard, *The Evolution of Social Behavior by Kin Selection* (pt. 1), 50 Q. REV. BIOLOGY 1 (1975) (Letter to the Editors); W. D. Hamilton, *The Evolution of Altruistic Behavior,* 97 AM. NATURALIST 354 (1963); and W. D. Hamilton, *The Genetical Evolution of Social Behavior,* 7 J. THEORETICAL BIOLOGY 1 (1964). Quite accessible discussions also appear in GOLDSMITH, *supra* note 16, at 39-41; TRIVERS, *supra* note 43, at 45-47; WRIGHT, *supra* note 1, at 155-79. It is important to note that the calculus is rather different for those social insects (such as ants, bees, and wasps) that have an unusual (haplodiploid) chromosomal structure, resulting in unusually cooperative behavior that is nonetheless entirely consistent with kin selection principles. *See* ROSS H. CROZIER & PEKKA PAMILO, EVOLUTION OF SOCIAL INSECT COLONIES: SEX ALLOCATION AND KIN SELECTION (1996); RANDY THORNHILL & JOHN ALCOCK, THE EVOLUTION OF INSECT MATING SYSTEMS (1983); Robert L. Trivers & Hope Hare, *Haplodiploidy and the Evolution of the Social Insects*, 191 SCI. 249, 261 (1976).

mulated, additive, RS calculation is known as "inclusive fitness."[45] That term, in turn, captures the idea that for any given individual (all else being equal) each of its reproductive offspring contributes as much, genetically, to that individual's reproductive success, as: a) one reproductive sibling or parent; b) two reproductive nieces, nephews, uncles, or grandchildren; c) four reproductive cousins; and so forth.[46] Thus, as will be explored further below, an organism's "self-interest" in reproductive success reduces to its promotion of inclusive fitness.[47]

3. The Ground Rule for the Game: Natural Selection

Every competitive game has rules that identify what equipment players may wear (their physical traits) and how they may behave (their behavioral traits). Additionally, there are rules to penalize transgressors. The closer the competition, the more the cumulative effects of such penalties will divide the winners from the losers. At first blush, the process known as "natural selection" operates like a rule system. Whom it mindlessly punishes, and how, eventually divides those who might win the evolutionary game from those who lose. Natural selection appears simply to punish organisms that fail to reproduce by precluding their genetically influenced traits from being represented in future populations. But understanding some of the nuances of natural selection is critical to proper evolutionary analysis, and to later appreciating the powerful role it can play when

45. *See* ALCOCK, *supra* note 16, at 506-10. Inclusive fitness can also be thought of as the sum of indirect and direct fitness, which is the total genetic contribution of an individual to the subsequent generation. *See supra* note 39.

46. *See* Martin Daly & Margo I. Wilson, *Child Maltreatment from a Sociobiological Perspective*, *in* DEVELOPMENTAL PERSPECTIVES ON CHILD MALTREATMENT 93, 100 (Ross Rizley & Dante Cicchetti guest eds., 1981) (New Directions for Child Development Series, No. 11, William Damon ed.) [hereinafter Daly & Wilson, *Child Maltreatment*].

47. *See id.* at 100. This, incidentally, is why Spencer's inapt (but catchy) bumper-sticker phrase "survival of the fittest," which launched the ill-begotten Social Darwinism, is so misleading. (On Spencer's influence on Social Darwinism, see RICHARD HOFSTADTER, SOCIAL DARWINISM IN AMERICAN THOUGHT 39 (1992)). First, survival is relevant only to the extent that it contributes to reproduction. In many species, creatures who sacrifice their lives in the reproductive effort have greater reproductive success than those who do not but who survive longer. *See, e.g.*, Maydianne C.B. Andrade, *Sexual Selection for Male Sacrifice in the Australian Redback Spider*, 271 SCI. 70 (1996). Second, fitness is not measured only by an organism's ability to reproduce. It sums that ability, in a precise way, with the abilities of other relatives. Under some conditions, an individual can maximize reproductive success by not reproducing and instead contributing to the reproduction of its relatives. *See* THORNHILL & ALCOCK, *supra* note 44, at 41-42; Paul Sherman et al., *Naked Mole Rats*, SCI. AM., Aug. 1992, at 72, 73; Trivers & Hare, *supra* note 44, at 261 (certain insects).

we design systems to pursue the goals of law.[48]

Natural selection, like a giant colander sorting small pebbles from large, sifts the less reproductively successful members of a species from the more reproductively successful. While this sifting is non-purposeful, in that it is caused by a mindless and often hostile environment, it also is decisively non-random.[49] The key to understanding the precise nature of this sifting lies in the interrelationship between three features observable in most species:

- Heredity: Genetically influenced physical and behavioral traits sometimes pass from parent to offspring (in which case they are called "heritable").[50]
- Variation: Individuals of a species may differ in their physical and behavioral traits.[51]
- Differential Reproduction: Some inherited traits will enable some individuals possessing them to leave more offspring and reproductive relatives than others.[52]

As the following paragraphs will explain in greater detail, "natural selection" is the inevitable result of combining these three fundamental features of life on our planet.

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48. Technically, natural selection is one of four factors influencing gene frequencies. *See* GOLDSMITH, *supra* note 16, at 29-31. The other three are: 1) mutation, involving replication errors in genetic codes; 2) gene flow, referring to migration of genes between populations due to the movement of organisms carrying them; and 3) random drift, which describes effects of chance events, such as accident or disease, on reproductive success. Of these four, natural selection has by far the most powerful influence. *See id.*

49. It is a profound mistake to consider evolution an argument that organisms arise by mere chance. As an example of this mistake, see Arthur S. Lodge, *Theory of Evolution Is Still Evolving*, WALL ST. J., July 28, 1995, at A15 (letter to editor incorrectly asserting that evolutionary theory contends "that all living things on earth have been by chance," in response to prior letter of law professor Larry Frolik, which had criticized the teaching of creationism in the classrooms). The selective power of natural selection is quite unlike random chance. *See* RICHARD DAWKINS, CLIMBING MOUNT IMPROBABLE (1996) (contrasting the incremental process by which natural selection shapes adaptations with the supposedly sudden effects of chance alone). If a trait arises that provides even a 2% reproductive advantage to an organism bearing it, compared to a specific, coexisting alternative, the former can drive the latter to extinction in merely 200 generations. *See* Tim Goldsmith, Is Culture Really Not Part of Our Biology?, Address to the Law, Biology, and Human Behavior Teaching Conference (June 27, 1995). At the same time, nevertheless, the general effect of natural selection upon the traits of successive populations of a species is also inevitably sensitive to some random shocks occasioned by luck, which may, for example, affect the precise composition of localized breeding populations.

50. *See* ALCOCK, *supra* note 16, at 6.

51. *See id.* Variations are the things that prevent us from calling parent and offspring "identical." Variations relevant to the discussion at this point are those that are genetically inheritable, ultimately caused by mutation. *See* GOLDSMITH, *supra* note 16, at 29-30.

52. *See* ALCOCK, *supra* note 16, at 6.

Organisms that are not genetically identical often will differ in their physical and behavioral traits (resulting in within-species "variation"). Each genetically influenced (and thus "heritable") trait will prove "adaptive" (that is, advantageous), "maladaptive" (that is, disadvantageous), or "neutral" with respect to its effect on the reproductive success of the organism bearing it.[53] When an adaptive and heritable trait increases an individual's reproductive success relative to the reproductive success of the individual's contemporaries (resulting in "differential reproduction"), then that trait will correspondingly increase in prevalence in successive generations of a population. Conversely, when a maladaptive and heritable trait decreases the reproductive success of the organism bearing it relative to the reproductive success of the organism's contemporaries, then that trait, on average, will decrease in prevalence in successive generations. This phenomenon, which the term "natural selection" captures, therefore can be understood as one of the principal mechanisms governing the relative proportions of the various physical and behavioral traits that are observable in any particular generation of a species.

The most useful technique for grasping the effect this "rule" of natural selection has on the evolutionary game is to posit an ancient population in which variations are introduced, and to estimate how each variation would fare in successive generations. For example, imagine a herd consisting of 100 individual antelope (fifty female and fifty male) all of which share a species-typical ear shape (as a function, of course, of prior evolutionary processes). Imagine that in arbitrarily named Generation 1 two heritable mutations (copying errors in the genetic code), each of which affects adult ear shape, appear simultaneously in two infant females. One mutation results in a slight advantage (over both the second female and all the other females) in, say, that female's ability to hear predators sneaking up on

53. In other words, the trait might: promote reproductive success (as through improved detection of predators); impede reproductive success (as through an urge to run toward, rather than away from, a predator); or have no effect whatsoever on reproductive success (as through introduction of genes that never activate, and therefore have no significance for the organism bearing them). In reality, very few variations are adaptive—as there are more ways to worsen something than to improve it. However, because even infrequently occurring adaptive variations tend, on average, to supplant less adaptive alternatives over successive generations, physical structures and behavioral tendencies that most efficiently contribute to individual reproductive success become increasingly prominent. Many adaptations are simply so successful that they become shared by all members of the species many generations hence. For a concise discussion, see Martin Daly & Margo Wilson, *Discriminative Parental Solicitude: A Biological Perspective*, 42 J. MARRIAGE & FAM. 277, 278 (1980).

her. This gives her a slightly better chance than that of any other female of surviving to reproductive age. If she successfully reproduces, contributing to Generation 2, roughly 50% of her offspring are likely to share her genetically enhanced hearing and will likewise receive a slight advantage over their contemporaries.

In contrast, imagine that the second female's mutation results in a slight disadvantage (compared both to the first female and to all other females) in the second female's ability to hear predators sneaking up on her. This gives her a slightly worse chance than that of any other female of surviving to reproductive age. If she does survive and reproduce, contributing to Generation 2, roughly 50% of her offspring will share her poorer hearing, putting them too at a slight disadvantage with respect to survival, and thence to reproduction.

What will the population look like at, say, Generation 1000—merely 998 generations hence? Separate and simple calculations (demonstrating the power of exponential growth) reveal that even a trait providing its possessor with only a 1% reproductive advantage over its contemporaries can swell from 1% representation in a population to 99% in merely 265 generations.[54] There will probably, therefore, be more descendants of the first female than of the second female, and perhaps even more descendants of the first female than of any other female from Generation 1 (depending upon the relative contribution to reproductive success of acute hearing compared to that of alternatively arising traits, such as longer necks or superior camouflage). The first female will have her genes represented in a larger proportion of the later population. Consequently, we may predict that natural selection, by punishing poorer hearing, would effectively favor the "better-hearing," more adaptive ear shape and let it spread throughout future populations.

The same analysis obtains for genetically influenced *behavioral* characteristics.[55] Every behavioral act has consequences, and natural

54. *See* TRIVERS, *supra* note 43, at 28-29.

55. *See* ALCOCK, *supra* note 16, at 57-88; MICHAEL S. GAZZANIGA, NATURE'S MIND: THE BIOLOGICAL ROOTS OF THINKING, EMOTIONS, SEXUALITY, LANGUAGE, AND INTELLIGENCE (1992); QUANTITATIVE GENETIC STUDIES OF BEHAVIORAL EVOLUTION (Christine R.B. Boake ed., 1994); TRIVERS, *supra* note 43; Ralph J. Greenspan, *Understanding the Genetic Construction of Behavior*, SCI. AM., Apr. 1995, at 72-78; articles collected in *Genes and Behavior*, 264 SCI. 1686, 1686-1739 (1994).

Humans pass behavioral traits culturally, as well as genetically. While they are not the only animals to pass behavioral traits through non-genetic means, they are particularly adept at doing so. Although this capability is beyond the scope of this Article, some of the more interesting examples of literature attending to the intersection of culture and evolution include ROBERT BOYD & PETER J. RICHERSON, CULTURE AND THE

selection operates inexorably upon genetically influenced consequences, whenever they serve to differentiate individual organisms in ways that affect reproductive success.[56] This effectively creates evolved psychologies, to the extent that a psychology is a short way of describing species-typical information processing pathways tending to yield some behaviors, in given circumstances, more than others.[57] For example, observe that individuals tend, even without "learning," to mate with members of their own species. Why? The analytic technique just demonstrated, for estimating how genetic variations would fare in successive generations, makes clear that if a novel gene combination arose in Generation 1, predisposing its bearer to spend precious time and energy pursuing ultimately non-reproductive copulation with members of an unrelated species, that combination is unlikely to be represented in a significant portion of the population in Generation 1000. The same would be true for thousands of other gene combinations predisposing their bearers to be less interested in mating, less capable of correctly identifying opposite-sex members of their own species, inappropriately calibrated with respect to when they should be hungry, and so on. This is also true for an extraordinarily diverse set of other behavioral traits that affect reproductive success.

Natural selection is therefore a non-directed yet non-random process of differential reproduction, as a consequence of genetic variation, that tends to make animals of existing species look as if

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EVOLUTIONARY PROCESS (1985); L.L. CAVALLI-SFORZA & M.W. FELDMAN, CULTURAL TRANSMISSION AND EVOLUTION: A QUANTITATIVE APPROACH (1981); W.H. DURHAM, COEVOLUTION: GENES, CULTURE AND HUMAN DIVERSITY (1990); THE ETHOLOGICAL ROOTS OF CULTURE (R. Allen Gardner et al. eds., 1994); Robert Boyd & Peter J. Richerson, *Why Does Culture Increase Human Adaptability?*, 16 ETHOLOGY & SOCIOBIOLOGY 125 (1995); Leda Cosmides & John Tooby, *Evolutionary Psychology and the Generation of Culture: Case Study, Part II: A Computational Theory of Social Exchange*, 10 ETHOLOGY & SOCIOBIOLOGY 51 (1989); Goodenough, *Mind Viruses*, *supra* note 3; Kiyosi Takahasi & Kenichi Aoki, *Two-Locus Haploid and Diploid Models for the Coevolution of Cultural Transmission and Paternal Care*, 146 AM. NATURALIST 651 (1995); John Tooby & Leda Cosmides, *Evolutionary Psychology and the Generation of Culture, Theoretical Considerations, Part I*, 10 ETHOLOGY & SOCIOBIOLOGY 29 (1989).

56. *See* ROBERT A. HINDE, ETHOLOGY: ITS NATURE AND RELATIONS WITH OTHER SCIENCES 102 (1982).

57. These pathways can be extremely context-sensitive. As Tim Goldsmith describes the "Garcia Effect," rats made ill by x-ray doses delivered after eating will associate their delayed distress with the taste but not with the shape or color of the food. Conversely, if given a shock while eating, rats remember visual or auditory cues, but not taste cues. As a function of natural selection, eating-related cues are far more readily associated with subsequent internal distress than auditory or visual cues. *See* GOLDSMITH, *supra* note 16, at 97-98.

they were designed to survive and reproduce in their ecological niche.[58] Though its influence surrounds us, we know natural selection only by silhouette, as it incessantly eliminates traits carried by organisms that reproduce less successfully than their contemporaries.[59]

It is important to recognize that, most typically, only those traits helping *individuals* to improve their reproductive success can proliferate. Inheritable traits that might help the group or species to survive, at the expense of individual gains to inclusive fitness, would generally diminish toward disappearance.[60] This means that under most circumstances natural selection operates primarily at the level of the individual or gene, and not at the level of the group.[61] In other words, it is unlikely that a trait could ever arise and persist in individuals that benefits the group at the *expense* of an individual's own reproductive success.[62]

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58. Richard Dawkins calls natural selection the "blind watchmaker," as an implicit refutation of the creationist argument that such design implies a conscious designer, in the same way that a watch supposedly implies a watchmaker. *See* DAWKINS, *supra* note 14, at 4-5.

59. Although natural selection is the principal rule in the game of evolution, a supplemental, special rule that applies only to species that sexually reproduce will be discussed *infra* section I.B.4.c.

60. Think, for example, of a heritable trait in deer predisposing its possessor to raise, during times of overpopulation, far fewer offspring than it is physically capable of raising, or of a heritable trait in trees predisposing its possessors to grow less tall—on the chance that all members of the species would benefit by collecting the same amount of sunlight as they do now if they halted their competitive, intra-species height race. Such traits would be at an extreme disadvantage relative, respectively, to a trait prompting unrestrained reproductive effort, or unrestricted competition for more sunlight.

61. *See* RICHARD DAWKINS, THE SELFISH GENE (1976); FUTUYMA, *supra* note 14, at 114-31; HINDE, *supra* note 56, at 142-53; TRIVERS, *supra* note 43, at 67-85; *see also* GEORGE C. WILLIAMS, ADAPTATION AND NATURAL SELECTION: A CRITIQUE OF SOME CURRENT EVOLUTIONARY THOUGHT (1966) [hereinafter WILLIAMS, ADAPTATION AND NATURAL SELECTION] (considered to have eviscerated "naive" group selectionism as espoused by V.C. Wynne-Edwards in ANIMAL DISPERSION IN RELATION TO SOCIAL BEHAVIOUR (1962)). Some have argued that the "selfish gene" thesis has been a bit overstated. George Williams has recently urged that if we pay more attention to units of heredity (replicators) rather than to units of selection (vehicles) we will see that natural selection, under some circumstances, can also operate at other levels. *See* GEORGE WILLIAMS, NATURAL SELECTION: DOMAINS, LEVELS, AND CHALLENGES (1992); *accord* ELIZABETH LLOYD, THE STRUCTURE AND CONFIRMATION OF EVOLUTIONARY THEORY (1988); ELLIOTT SOBER, THE NATURE OF SELECTION: EVOLUTIONARY THEORY IN PHILOSOPHICAL FOCUS (1984); *see also* Wilson & Sober, *supra* note 14, at 585 (arguing that "the vehicle based theory makes it clear that group selection is an important force to consider in human evolution"). On the history and significance of the debate, see Ernst Mayr, *Driving Forces in Evolution: An Analysis of Natural Selection, in* THE EVOLUTIONARY BIOLOGY OF VIRUSES 29 (Stephen S. Morse ed., 1994).

62. The questions this raises with respect to the evolution of cooperation and "altruism" are addressed *infra* section I.B.5.b.

4. The Strategies for the Game: Reproductive Strategies

The rules of a game circumscribe effective strategies for playing. Consequently, natural selection's relentless sweeping away of individuals with relatively low reproductive success inevitably exposes, like rocks at low tide, a variety of more successful "reproductive strategies" for generating relatives. These are simply the different (and typically unconscious) successful physiological and behavioral pathways to becoming an ancestor that natural selection has not swept from existence. "Strategies" is plural here because, while natural selection favors physical structures and behavioral predispositions that together function successfully to transfer genes to subsequent generations, there are many different successful combinations. These vary according to the number of offspring one produces, the extent to which each offspring is cared for after birth, whether reproduction is asexual or sexual, and so forth.

This section features two important variables in reproductive strategies—the amount of parental investment and the existence or absence of sexual reproduction. The latter warrants a brief but separate discussion of special rules applicable to sexually reproducing species. This is followed by a brief explanation of behavioral predispositions that may vary, sensitive to environmental conditions.

a. Parental Investment

One of the most important variables in any reproductive strategy is parental investment (known as "PI"), which is any investment by the parent in an individual offspring that increases that offspring's chance of surviving and reproducing at the cost of the parent's ability to invest in other offspring.[63] Contrary to intuition, perhaps, simply maximizing the number of offspring born is *not* necessarily a dominant reproductive strategy. An offspring contributes to reproductive success *only* if it reaches adulthood and successfully reproduces (or assists its relatives in doing so). Because each offspring is a separate investment of finite parental resources (from body, time, and energy), quantity eventually trades against quality. Increasing the *number* of offspring eventually requires decreasing parental investment *per* offspring. An ocean sunfish, for example, may release as

63. *See* Robert L. Trivers, *Parental Investment and Sexual Selection*, *in* SEXUAL SELECTION AND THE DESCENT OF MAN 136, 139 (B. Campbell ed., 1972) [hereinafter Trivers, *Parental Investment and Sexual Selection*]; Robert L. Trivers, *Parent-Offspring Conflict*, 14 AM. ZOOLOGY 249 (1974) [hereinafter Trivers, *Parent-Offspring Conflict*].

many as 300,000,000 eggs in a single clutch.[64] It invests nothing in raising the young, however, and therefore only a few survive. Near the other extreme, the human animal invests extraordinary amounts in every offspring, many of which survive. But humans must then inevitably produce fewer offspring at a single time. There are many different, intermediate, equally optimal balances between number of offspring and amount of parental investment, depending on how many offspring are produced, and how much a parent of a given species invests in each.

b. Sexual Reproduction

One way to invest in an offspring is through a long gestation period. In mammals, the longer the offspring can grow protected inside the parent's body and still successfully be birthed, the better its chances of surviving vulnerable infancy and reaching reproductive age. This component of a reproductive strategy, however, does not automatically require a separation of sexes within the species. Asexual reproduction (such as "budding" or "cloning") is less costly than sexual reproduction because it enables an organism to reproduce without diverting its time and energy to locating, attracting, and mating with others. Moreover, an organism reproducing asexually typically transmits twice as many of its genes to each offspring as does a sexually reproducing parent.

Why, then, is sexual reproduction so widespread? The question warrants some explanation, because the different economic costs imposed by natural selection on aspects of sexual reproduction are responsible for much of the behavior-shaping forces that affect human behavior. There are many theories to explain the prevalence of sexual reproduction, but the predominant one at present stresses the evolutionary significance of lowly parasites.[65]

Parasites evolved by exploiting the bodies of hosts, the way

64. *See* L. Scott Forbes & Douglas W. Mock, *Proximate and Ultimate Determinants of Avian Brood Reduction*, *in* INFANTICIDE & PARENTAL CARE 237, 237 (Stefano Parmigiani & Frederick S. vom Saal eds., 1994) (citing J. L. Hart, *Pacific Fishes of Canada*, Fisheries Research Board of Canada Bulletin No. 180 (1973)).

65. For a brief but sophisticated elaboration of this theory, see MATT RIDLEY, THE RED QUEEN: SEX AND THE EVOLUTION OF HUMAN NATURE 55-87 (1994). Other examples include, W.D. Hamilton, *Sex Versus Non Sex Versus Parasite*, 35 OIKOS 282 (1980); R. Stephen Howard & Curtis M. Lively, *Parasitism, Mutation Accumulation and the Maintenance of Sex*, 367 NATURE 554 (1994); R. Ladle, *Parasites and Sex: Catching the Red Queen*, 7 TRENDS ECOLOGY & EVOLUTION 405 (1992). For brief overviews of the sex conundrum, see GOLDSMITH, *supra* note 16, at 47-49 and Roger V. Short, *Why Sex?*, *in* THE DIFFERENCES BETWEEN THE SEXES 3 (R.V. Short & E. Balaban eds., 1994).

hosts, in turn, evolved to exploit their own environment. But because hosts are already engaged in a stiff competition over RS, every parasitic freeloader inevitably weakens them, penalizing them in the competition with any parasite-free contemporaries.[66] Since natural selection will favor hosts resistant to parasites, as well as parasites that defeat host defenses, the hosts and parasites are in a constant arms race. Were the game a fair one, an equilibrium standoff might ensue. But the game is not fair, and parasites have one distinct advantage: Short generation spans. Certain species of bacteria, for example, can produce a new generation every twenty minutes in the body of a human, while their human hosts produce a new generation about once every twenty-eight years.[67] This means that the physical and behavioral traits of parasitic species can evolve faster than those of their host species (because each generation provides a new opportunity for genetic variation) and that they will inevitably outrace the hosts whenever hosts exhibit little genetic variation between successive generations.

In asexual reproduction, offspring are genetically identical to the parent (excluding random mutations). This leaves asexually reproducing individuals extremely vulnerable to the various weapons that evolve within the tiny organisms who parasitize and exploit them. Sexual reproduction, on the other hand, reshuffles the host's genetic deck between each generation. This has the effect of restarting the arms race every time the parasites get ahead.[68] Because more than half of all organisms in the world are parasites, and because most non-parasitic organisms are infected with parasites for at least some

66. Because parasites that regularly kill their hosts before reproducing would have extremely low reproductive success, a parasite's virulence is generally and directly related to the speed with which it can infect new hosts. Highly virulent strains of sexually-transmitted diseases, like AIDS, flourish more readily when the number of partners per host per unit of time is very high, while less virulent strains achieve greater relative success when the number of partners per host per time is very low. For more on the evolution of viruses, see THE EVOLUTIONARY BIOLOGY OF VIRUSES (Stephen S. Morse ed., 1994); PAUL W. EWALD, EVOLUTION OF INFECTIOUS DISEASES (1994); Paul W. Ewald, *The Evolution of Virulence*, SCI. AM., Apr. 1993, at 86.

67. Personal Communication with Dr. Michael McGuire, Professor of Psychiatry and Behavioral Sciences, University of California at Los Angeles, in Squaw Valley, Cal. (June 24, 1996).

68. One complication of this theory as an explanation for sexual reproduction is the way our immune systems operate. Antibodies are produced by somatic cell mutation and recombination at a tremendous rate and in a directed (i.e., clonal selection) way. Given this capability, it is unclear why the germ line (sex cell) recombination noted in the text is also necessary. Personal Communication with William Zimmerman, Professor of Biology, Amherst College Department of Biology (Jan. 25, 1996).

of their lifetimes,[69] natural selection generally favors sexual reproduction over asexual reproduction (especially in species with long generation spans).[70]

c. Sexual Selection: A Special Rule for a Special Strategy

The pressure of natural selection yields sexual reproductive strategies, but these in turn create new pressures and rules. Sexual reproduction requires mating, and mating requires mates. The competition to attract mates and exclude rivals imposes evolutionary pressures occasionally at odds with those encouraging simple survival. Darwin himself recognized that natural selection (as he had articulated it) could not alone account for all the characteristics creatures manifest. Things like elaborate peacock tails, for example, seemed more likely to increase than to reduce vulnerability to predation. At first glance, this would seem to reduce the reproductive success of peacocks with such tails.

To explain the persistence of such attributes, Darwin proposed the existence of a process now known as "sexual selection"[71] (now generally considered to be a special sub-aspect of natural selection[72]). Imagine a sexually reproducing species (of mammal, for example) manifesting an evolved reproductive strategy that requires individuals: a) to reproduce sexually; b) to fertilize internally; and c) to produce live young. In such a species one sex typically *must* invest

69. *See* P.W. PRICE, EVOLUTIONARY BIOLOGY OF PARASITES vi-vii, 8 (1980).

70. To date, field and experimental evidence tends to support this hypothesis. *See, e.g.*, C.M. Lively, *Evidence from a New Zealand Snail for the Maintenance of Sex by Parasitism*, 328 NATURE 519 (1987) (reporting that, in a snail species that can reproduce either sexually or asexually, sexual reproduction is strongly correlated with parasitism); Guiyun Yan & Lori Stevens, *Selection by Parasites on Components of Fitness in Tribolium Beetles: The Effect of Intraspecific Competition*, 146 AM. NATURALIST 795 (1995) (reporting that parasitism strongly affects host reproductive success when intra-species competition is high). Incidentally, there is much to suggest that the powerful effect of parasites on body symmetry, color, and physical performance plays a crucial role in sexual selection, which is the subject of the immediately following section. *See, e.g.*, D.H. Clayton, *The Influence of Parasites on Host Sexual Selection*, 7 PARASITOLOGY TODAY 329 (1991); William D. Hamilton & M. Zuk, *Heritable True Fitness and Bright Birds: A Role for Parasites?*, 218 SCI. 384 (1982).

71. Sexual selection was first described in Chapter IV of CHARLES DARWIN, ON THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION (1859), and later elaborated at length in CHARLES DARWIN, THE DESCENT OF MAN AND SELECTION IN RELATION TO SEX (1871). For modern elaboration, see GOLDSMITH, *supra* note 16, at 43-45, 49-67; ANDERS PAPE MOLLER, SEXUAL SELECTION AND THE BARN SWALLOW (1994); RIDLEY, *supra* note 65, at 131-69; TRIVERS, *supra* note 43, at 203-70; Trivers, *Parental Investment and Sexual Selection*, *supra* note 63.

72. *See, e.g.*, HELENA CRONIN, THE ANT AND THE PEACOCK: ALTRUISM AND SEXUAL SELECTION FROM DARWIN TO TODAY 234 (1991).

more in the creation of a viable offspring than must the other sex. In addition to mating time and energy, for example, the male has to invest only sperm. On the other hand, if copulation yields conception, the female must continue to invest in the organism growing within her, frequently for long periods, and must often assist the vulnerable young (by nursing it, for example) for some significant post-birth period. Following conception in such a species, the male investment, although useful, is not technically necessary for birth or infant care.

This disparity in minimum investment between males and females in such a species produces a disparity in potential cost-benefit payoffs for every act of copulation. From a single act of copulation, a male may gain an offspring that carries his genes into future generations. While the female may gain a similar benefit from the same act, unlike the male she must first grow within her, and often rear, that offspring. Because she must nourish the growing embryo with the fruits of her body, the maximum number of offspring a female can grow and raise in a lifetime is comparatively limited. She is bound by the limits of her own body. The maximum number of young a male could father, on the other hand, is limited only by the number of females he can inseminate. The theoretical maximum number of children a male human could father, for example, could number in the thousands. The theoretical maximum number of children a female human could mother, on the other hand, even assuming frequent triplets, likely hovers near one hundred—with a practical limit probably in the vicinity of thirty.

In all species reflecting this disparity in reproductive maxima, females are generally the limiting resource for maximum male reproduction. These two critical features of sexual selection typically emerge: greater male-male than female-female competition for mates, and greater female than male choice (on average over a population) regarding who one's mate will be.[73] Some features and behaviors that might produce no immediate advantage for survival, food-acquisition, or offspring-rearing, therefore, can *still* be favored by sexual selection over time because they provide advantages over members of the same sex in the competition for access to, and choice

73. *See* MOLLER, *supra* note 71, at 3. Exceptions prove the rule. In seahorses, for example, in which female seahorses inject eggs into the male's body, where they develop, the females are the more active sex in courtship. *See* RIDLEY, *supra* note 65, at 180-81. Also, predictably larger, more brightly colored female phalaropes (such as sea snipes) display and fight for males, who, in these bird species, provide the larger share of egg-tending. *See* ALCOCK, *supra* note 16, at 458-59; TRIVERS, *supra* note 43, at 215-19; WRIGHT, *supra* note 1, at 48.

by, members of the other sex. Sexual selection is therefore the result of a non-random association between a given characteristic and a component of mating success, such as excluding rivals (with big antlers) or attracting mates (with colorful tail feathers).[74]

d. Condition-Dependent Strategies

Because circumstances vary significantly, an ability to shift among a variety of potential behaviors in response to endlessly shifting environmental conditions often proves adaptive.[75] For example, genetically influenced behavioral algorithms rendering an organism's aggressiveness particularly sensitive to the relative value of the territory it defends (say in food quality and abundance), and to the relative size of any challenger for that territory, tend to increase in frequency over successive generations compared to similar algorithms that cause fleeing or fighting behavior insensitive to the value of the territory. Many creatures therefore exhibit relatively simple condition-sensitive or "conditional" strategies that are continuously honed by natural selection to reflect the increasingly familiar logic of game theory.[76] Additionally, in species with advanced cognitive capacities, behavioral plasticity is further increased by an ability to analyze a very large number of variables, to assess probable outcomes as a consequence of given behaviors, and to choose among them. The existence of such an ability does not necessarily eclipse the influence of condition-dependent predispositions, but it does often diminish their influence.

5. The Strategies in Tension: On Conflict, Cooperation, and Deception

Thus far, it should be clear that persistent patterns in physical and behavioral traits of living things vary as a function of reproductive success, as measured by inclusive fitness. Reproductive success is then, in turn, mediated by the force of natural selection, the pressure of which yields reproductive strategies. Some of these strategies are sexual (resulting in sexual selection), and all involve delicate tradeoffs regarding the amount and kind of parental investment. The

74. *See generally* MOLLER, *supra* note 71, at 1-17 (providing an overview of sexual selection). Bright colors, incidentally, appear to be a reliable proxy for low parasite load. *See* Hamilton & Zuk, *supra* note 70.

75. A species' increasing behavioral plasticity inevitably carries its own costs, however, in terms of increased brain size, delayed reaction time, and the like.

76. *See, e.g.*, ALCOCK, *supra* note 16, at 297-99, 305-12, 414-15, 418-19, 553-55; *see also infra* text accompanying note 88.

important point is that these tradeoffs introduce varying degrees of intra-species conflict and cooperation into the evolutionary game, the varieties and combinations of which describe much of the vast diversity of animal behavior.

a. Conflict

Related but non-identical individuals can have overlapping but non-identical reproductive interests. In sexually reproducing species, consequently, we might divide common forms of conflict into four categories: 1) intra-sexual conflict; 2) inter-sexual conflict (including parent-parent conflict); 3) sibling-sibling conflict; and 4) parent-offspring conflict.[77]

Intra-sexual conflict is that over access to mates or other resources, as discussed above in the context of sexual selection. Where females are the limiting reproductive resource, male-male physical contests are the norm. *Inter-sexual conflict* results from differences between the sexes in their lifetime reproductive potential and minimum necessary investments in offspring (mentioned earlier) as well as in their certainty of relatedness to putative offspring. In internally fertilizing species, for example, a female is always related to the offspring of her own body, regardless of which male sired them. In contrast, paternity certainty is a special problem for males in species characterized by paternal assistance in offspring rearing, because a male may or may not be related to the infants he helps to raise. There are therefore dramatically different consequences to the individual reproductive success of males and females when they themselves or their mates engage in extra-pair copulations that result in conception, and natural selection must then exert different selective pressures on heritable predispositions in male and female mating behavior. For example, male mate-guarding during periods of female fertility is adaptive where paternity is uncertain, particularly when guarding varies in direct proportion to that uncertainty. Conversely, a female predisposition to solicit specific extra-pair copulations will be adaptive if on average it results in the conception of higher quality offspring than would be the offspring of the male partner that may in fact help to raise those offspring.[78]

77. Group-group conflict in social species is beyond the scope of this Article.

78. Even in some of the bird species typically considered to be monogamous, DNA analysis reveals that up to 40% of the young a male may help raise are not his own. *See* Robert B. Payne & Laura L. Payne, *Heritability Estimates and Behavior Observations: Extra-Pair Mating in Indigo Buntings*, 38 ANIMAL BEHAVIOUR 457 (1989); David F. Westneat et al., *The Ecology and Evolution of Extra-Pair Copulations in Birds*, 7

Sibling-sibling conflict is expected to be less intense than average conflict among non-relatives, but more intense than conflict among clones. For while each sibling is related to the other by roughly 50% (and therefore can further its own self-interest through the other's survival and reproductive success), each is nevertheless 100% related to itself. In the end, each receives twice the benefit by thriving at the cost of the other as it would by sacrificing itself to the other's benefit.[79] Put another way, each sibling can be expected, for example, to value the parental investment it receives twice as highly as parental investment its sibling receives—and to treat its parents and siblings accordingly.[80]

Parent-offspring conflict might be viewed, in part, as simply an epiphenomenon of competition between the siblings for a disproportionate share of parental investment. But in fact, genetic asymmetries between parent and offspring have their own, more directly powerful effects. Again, each is 50% related to the other but 100% related to itself. Thus, the incessant pressure from natural selection for each to optimize transmission of genes to subsequent generations yields overlapping but also conflicting interests in such things as the optimal length of the period of parental investment and in the optimal total amount of parental investment.[81] Offspring will typically seek more resources from parents capable of future reproduction than those parents will have been selected to provide, particularly as the offspring matures from necessary dependence to

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CURRENT ORNITHOLOGY 331, 334-35 (1990); *see also* T.R. BIRKHEAD & A.P. MOLLER, SPERM COMPETITION IN BIRDS: EVOLUTIONARY CAUSES & CONSEQUENCES 18-28 (1992).

79. In many species, aggression toward a sibling correlates with decreasing food supply. *See* Forbes & Mock, *supra* note 64, at 237, 245-46. In some species (like eagles, boobies, and pelicans), it is nearly routine for the elder sibling to eat the younger sibling shortly after it hatches. *See id.* Parents do not often intervene in such siblicide, perhaps because it would rarely be possible in such species to raise more than one offspring at a time, suggesting that the second egg is but an insurance against the unexpected failure of the first. *See id.* at 248-49. The young of some species of shark seek out and devour siblings inside the mother's oviduct—before they have even been born. *See* Wallace J. Dominey & Lawrence S. Blumer, *Cannibalism of Early Life Stages in Fishes, in* INFANTICIDE: COMPARATIVE AND EVOLUTIONARY PERSPECTIVES 43, 62-63 (Glen Hausfater & Sarah Blaffer Hrdy eds., 1984) [hereinafter INFANTICIDE]; R.G. Gilmore et al., *Reproduction and Embryonic Development of the Sand Tiger Shark, Odontaspis taurus (Rafinesque)*, 81 FISHERY BULL. 201 (1983).

80. On the unusually low sibling-sibling conflict of many social insects, see *supra* note 44.

81. *See* H.C.J. Godfray, *Evolutionary Theory of Parent-Offspring Conflict*, 376 NATURE 133 (1995); Virginia D. Hayssen, *Mammalian Reproduction: Constraints on the Evolution of Infanticide, in* INFANTICIDE, *supra* note 79, at 105; Trivers, *Parent-Offspring Conflict*, *supra* note 63, at 249-60.

possible independence.[82] Moreover, the relentlessly economizing process of natural selection yields the somewhat counter-intuitive proposition that parental investment is (from a genetic perspective) efficiently redirected away from one offspring whenever there is a probable increase in eventual parental reproductive success by doing so. Natural selection has therefore favored heritable predispositions to allocate investment among offspring commensurate with generally accurate indicators of that offspring's likely contribution to parental RS. The result is the widespread animal phenomenon of "discriminative parental solicitude" (or DPS), which may yield additional conflict.[83] As a consequence of DPS, for example, animal parents can increase their reproductive success by allocating more resources to a more promising offspring at the expense of another, or indeed by abandoning offspring that are sickly, weak, or deformed and investing elsewhere the resources thereby released (such as in future offspring).

b. Cooperation

Even individuals in conflict, of course, often will have overlapping interests that can generate cooperation. In the biological context, cooperation involves acts that appear "altruistic" (at least at first glance). Altruistic acts appear in two basic contexts: 1) those directed toward kin; and 2) those directed toward non-kin. The evolutionary origins of both can be explained by the logic of reproductive success, because such acts are widespread throughout the animal kingdom. But because the beneficiaries of both tend to differ precisely along the line of genetic relatedness, the two contexts require two different evolutionary explanations.

The evolution of altruism toward kin is more intuitively obvious, because improving the prospects of kin can contribute to reproduc-

82. For example, although it would not be advantageous for a primate infant to extract so much maternal investment that its mother dies before it achieves independence, it may often be advantageous to extract additional maternal investment that might come only at a cost to future siblings. *See* Sarah Blaffer Hrdy, *Fitness Tradeoffs in the History and Evolution of Delegated Mothering with Special Reference to Wet-Nursing, Abandonment, and Infanticide* [hereinafter Hrdy, *Fitness Tradeoffs*], *in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 3, 4; David Haig, *Genetic Conflicts in Human Pregnancy*, 68 Q. REV. OF BIOLOGY 495 (1993) (highlighting *in utero* tensions between human fetus and mother).

83. For a general overview, see Martin Daly & Margo Wilson, *Discriminative Parental Solicitude and the Relevance of Evolutionary Models to the Analysis of Motivational Systems, in* THE COGNITIVE NEUROSCIENCES 1269 (Michael S. Gazzaniga ed., 1995) [hereinafter Daly & Wilson, *Discriminative Parental Solicitude*]. This will be explored in detail below because of its centrality to the child abuse demonstration of the model.

tive success. Examples include providing resources to offspring (as already discussed), sharing resources with other relatives, and giving alarm calls to relatives about approaching predators. A *kin selection* model predicts that in each case natural selection will have favored those who provide relatives with such benefits in greater abundance, or more frequently, than non-relatives. The evidence bears this out rather strikingly, as parents often aggressively exclude non-relatives from receiving their parental investment (witness the persecution of an orphaned seal pup lost among unrelated mothers[84]) and, even in such highly social colonizing species as ground squirrels, the propensity to provide alarm calls is powerfully linked to the density of relatives in the immediate vicinity.[85] Those species that manifest cooperation typically exhibit well-developed mechanisms for identifying close relatives.[86]

The more difficult question is why individuals would *ever* favor *non-relatives* with resources, as they often do. Two models help explain this. The more intuitively obvious one is known as *mutualism*.[87] It simply describes, through now-familiar game theoretic terms, how cooperation with others can yield average reproductive success payoffs to each cooperator that exceed those achievable by each without cooperation.[88] For there are many times when even unrelated individuals may achieve more together than either could in isolation. The other model is known as *reciprocal altruism*,[89] and it applies in contexts in which there is a deferred reproductive gain for the helper, providing a net reproductive gain to the helper over not helping in the first instance. In such circumstances, genetically-influenced altruistic behavior toward unrelated individuals can still be sufficiently

84. *See, e.g.*, Burney J. Le Boeuf & Claudio Campagna, *Protection and Abuse of Young in Pinnipeds*, *in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 257, 259, 260, 264.

85. *See* TRIVERS, *supra* note 43, at 110-12; Paul W. Sherman, *Nepotism and the Evolution of Alarm Calls*, 197 SCI. 1246, 1252 (1977). For an overview of mechanisms by which organisms recognize kin, see David W. Pfennig & Paul W. Sherman, *Kin Recognition*, SCI. AM., June 1995, at 98.

86. *See, e.g.*, KIN RECOGNITION (Peter G. Hepper ed., 1991); Pfennig & Sherman, *supra* note 85.

87. *See* ALCOCK, *supra* note 16, at 506.

88. *See, e.g.*, ROBERT AXELROD, THE EVOLUTION OF COOPERATION (1984); KARL SIGMUND, GAMES OF LIFE: EXPLORATIONS IN ECOLOGY, EVOLUTION, AND BEHAVIOR 155-206 (1993); JOHN MAYNARD SMITH, DID DARWIN GET IT RIGHT? ESSAYS ON GAMES, SEX AND EVOLUTION (1988); JOHN MAYNARD SMITH, EVOLUTION AND THE THEORY OF GAMES (1982); PHILIP D. STRAFFIN, GAME THEORY AND STRATEGY (1993); JORGEN W. WEIBULL, EVOLUTIONARY GAME THEORY (1995).

89. *See* ALCOCK, *supra* note 16, at 506; Robert Trivers, *The Evolution of Reciprocal Altruism*, 46 Q. REV. BIOLOGY 35 (1971).

adaptive to increase in frequency in successive populations.

c. Deception and Self-Deception

Competition can make deception adaptive. Within prey species, for example, natural selection favors such deceptive traits as camouflage (to avoid detection by predators) and mimicry (to take free-riding advantage of adaptive features in other species). However, the pervasive conflicts of interest *within* species, as well as the particular fragility of cooperative relations between genetically unrelated individuals, also provide opportunities favoring heritable abilities to deceive. The ability to elicit altruistically cooperative acts from others without reciprocating, for example, makes Gullible's loss Deceiver's gain. And gains that translate into increased relative reproductive success tend to be adaptive. Unsurprisingly, then, animal communication systems hardly perform as unsullied vehicles for transmission of truth.

Yet the very adaptiveness of deception creates countervailing pressures favoring the ability to detect deception—and to discriminate carefully among potential recipients of cooperative acts. A coevolutionary struggle often follows, "with more skillful deception being matched by greater powers of detecting deception."[90] This arms race does two things. First, it favors advanced intellectual capabilities: to evaluate an actual return on altruistic investment (thereby detecting bad bargains); to identify individuals as individuals; to associate individuals with good or bad past bargains; to avoid future interactions with bad-bargain individuals (or "cheaters"); and to detect physiological and behavioral cues of would-be deceivers.[91] Second, it eventually favors self-deception in deceivers, rendering a deceptive intent unconscious to the practitioner, thereby eliminating the physiological and behavioral cues, such as nervousness and other subtle signs of stress, that might give the deception away.[92]

Because the adaptiveness of deception increases with increased social interaction, the ability of any one individual to engage in de-

90. Robert Trivers, *Deceit and Self-Deception: The Relationship Between Communication and Consciousness*, *in* MAN AND BEAST REVISITED 175, 176 (Michael H. Robinson & Lionel Tiger eds., 1991).

91. *See, e.g.*, Linda Mealey et al., *Enhanced Memory for Faces of Cheaters*, 17 ETHOLOGY & SOCIOBIOLOGY 119 (1996).

92. On deceit and self-deceit generally, see TRIVERS, *supra* note 43, at 395-420; WRIGHT, *supra* note 1, at 263-86; Randolph M. Nesse, *The Evolutionary Functions of Repression and the Ego Defenses*, 18 J. AM. ACAD. PSYCHOANALYSIS 260 (1990); *see also* LOYAL D. RUE, BY THE GRACE OF GUILE: THE ROLE OF DECEPTION IN NATURAL HISTORY AND HUMAN AFFAIRS (1994).

ception, counter-deception, and self-deception under varying conditions makes these behaviors particularly prominent among highly social species.[93] For example, many species with advanced cooperative mechanisms—such as chimpanzees—manifest deception, counter-deception, and a deeply emotional moralistic aggression. The institutionalized ostracism of habitual cheaters may indeed evidence the biological underpinnings of proto-legal systems.[94]

6. *Homo sapiens sapiens*

Of what relevance is all this to human behavior? A very great deal. The theories summarized above are as robustly "factual" as many other theories and things we commonly accept as true.[95] The general, evolutionary processes ordering the existence and persistence of heritable traits, and their increasing or decreasing prominence among successive populations, are not subject to significant debate within the scientific community. Because all available evidence indicates that these various evolutionary processes have affected all species that ever lived, and because *Homo sapiens sapiens* is descended from pre-existing species, it is currently *at least* clear that these processes affected the physical form and behavior of human ancestors at some time.

The question, of course, is whether this historical influence of evolutionary processes on human ancestors continues to affect modern human behavior in significant ways. The overwhelming probability is that it does. First, because evolutionary pressures have long shaped the behavior of human ancestors, one should start from a presumption (allowably rebuttable) that they still do. This is consistent with the allocation in other areas of science of burdens of persuasion, by use of presumptions, reflecting the logical—though of course not infallible—power of parsimony.[96] The opposite presump-

93. Many believe that the selection pressures yielding the complex human brain are more the result of an intra-species arms race over deception and counter-deception than of other environmental conditions typically associated with survival. *See, e.g.*, RIDLEY, *supra* note 65, at 329-37.

94. *See supra* notes 4-6 and accompanying text.

95. *See supra* note 14. For further background, see ALCOCK, *supra* note 16; FUTUYMA, *supra* note 14; GOLDSMITH, *supra* note 16; TIMOTHY H. GOLDSMITH & WILLIAM F. ZIMMERMAN, BIOLOGY, EVOLUTION, AND HUMAN BEHAVIOR (forthcoming 1999); J.R. KREBS & N.B. DAVIES, AN INTRODUCTION TO BEHAVIOURAL ECOLOGY (3d ed. 1993); MARK RIDLEY, EVOLUTION (1993); TRIVERS, *supra* note 43.

96. *See generally* HEMPEL, *supra* note 14, at 40-45 (discussing parsimony); *infra* notes 305-07 and accompanying text (discussing, in more detail, presumptions and burdens of persuasion). *But see* ELLIOTT SOBER, FROM A BIOLOGICAL POINT OF VIEW: ESSAYS IN EVOLUTIONARY PHILOSOPHY 136-57 (1994) (cautioning against overzealous application

tion would necessarily be ahistorical, reasoning backwards from unconnected and narrowly contemporary conjecture.[97]

Second, although individual humans can inject highly abstract analysis into their behavior-governing processes, we continue to observe humans engaging in specific and non-random patterns of behavior (in, for example, sexual jealousies, mate-guarding, violent confrontation, status-seeking, and offspring-obsessions) that are entirely consistent with patterns observable in many other species that do not share our capacity for abstract analysis.[98]

Third, no one has yet presented argument or evidence sufficient to overcome the presumption. We have encountered nothing at all troubling in the fit between theory and data to supply the kind of Kuhnian crisis necessary to *require* a conclusion that modern human behavior is *not* influenced by natural selection.[99] It would be thoroughly illogical to presume, for example, that what we call human "mind" is incompatible with the existence of important, evolutionary influences on human behavior.[100] Similarly, it would be wrong to presume either that there cannot be both proximate and ultimate causes of human behavior or that the existence of maladaptive human behaviors somehow disproves evolutionary influences on behavioral predispositions. Individuals of *all* species are more or less living fossils—bearing the imprint not of the *current* environment, but rather of the environment (technically the "environment of evolutionary adaptation" or EEA) in which currently manifested, heritable traits evolved—having proved adaptive over time.[101] "Increasing fitness" is

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of the principle of parsimony).

97. Moreover, for humans to establish a presumption that humans are, alone among all species, exempt from evolutionary influences on behavior would appear suspiciously anthropocentric (not to mention arrogant and narcissistic).

98. *See, e.g.*, DAVID M. BUSS, THE EVOLUTION OF DESIRE: STRATEGIES OF HUMAN MATING (1994); MARTIN DALY & MARGO WILSON, HOMICIDE 187-219 (1988) [hereinafter DALY & WILSON, HOMICIDE]; HELEN E. FISHER, ANATOMY OF LOVE: THE NATURAL HISTORY OF MONOGAMY, ADULTERY, AND DIVORCE (1992); RIDLEY, *supra* note 65; Douglas T. Kenrick, *Bridging Social Psychology and Sociobiology: The Case of Sexual Attraction*, *in* SOCIOBIOLOGY AND THE SOCIAL SCIENCES 5 (Robert W. Bell & Nancy J. Bell eds., 1989). Many believe, in any event, that our highly developed analytical abilities evolved as an adaptation that furthers the effectiveness of these behaviors. *See supra* note 93.

99. *See generally* THOMAS S. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS 66-91 (2d ed. 1970) (elaborating the now well-known idea that some shifts in scientific frameworks (paradigms) follow the perception of anomalies (crises)).

100. One could not, in any event, reason from the supposition that *some* important human behaviors were not subject to evolutionary pressures to the conclusion that *no* important human behaviors are so subject.

101. Rapid environmental changes can dramatically outpace a species' slow adaptation. Thus, the fact that humans have completely (and almost instantaneously—in

not in itself a conscious, psychological goal. Rather, psychological processes, reflected in emotions and information-processing patterns, evolved as means to the end of fitness in the social and material environments of evolutionary adaptation.[102] Some of these remain adaptive when social and material conditions change, and some do not.

Fourth, a prevalent competing hypothesis, that all relevant human behavior is socially constructed, exhibits several glaring weaknesses.[103] It is environmentally deterministic, for example, and is therefore as incoherent as would be a genetically deterministic theory. That hypothesis also requires a theory (to date unarticulated and suspiciously bootstrapping) that could explain the process by which a species could evolve beyond the influence of the processes that shaped it. That, in turn, requires that one posit the improbable—a precise moment in history at which time either: a) a living organism forever nullified the effects of its own genotype; or b) an organism with evolved behavioral predispositions had an offspring without behavioral predispositions.

Consequently, and with knowledge of evolutionary processes, one may expect that humans would behave in many ways that they do even without their higher reasoning capabilities. One may expect, for example, that humans *on average* will devote extraordinary energy to sex and child-rearing activities, will allocate attentions differently to kin and non-kin, will exhibit sex differences in behavior, will exhibit aggression in non-random patterns, will have psychological/emotional reactions that would have furthered reproductive success during an environment of evolutionary adaptation, will cooperate and defect from cooperation in patterns consistent with game-theory, and so on. And in fact, results of numerous experiments and studies in human

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evolutionary time) altered the environments within which they live, says exactly nothing about whether or not particular behaviors, even if maladaptive within those environments, remain influenced by past selection. We would not think to argue, for example, that a predisposition toward sweet (and hence high-calorie) foods is not genetically influenced merely because our nearly unlimited access to modern refined sugars make such cravings arguably maladaptive. *See* Martin Daly & Margo Wilson, *Anti-Science and the Pre-Darwinian Image of Mankind*, 93 AM. ANTHROPOLOGIST 162, 163-64 (1991) [hereinafter Daly & Wilson, *Anti-Science*]; Low, *supra* note 16, at 42-43. Moreover, there will always be creatures that behave in maladaptive ways (through conscious choice or otherwise). Natural selection does not prevent such things from occurring, it only prevents them from becoming the norm for long periods of time.

102. *See* Daly & Wilson, *Anti-Science, supra* note 101, at 164.

103. For examples of additional critiques, see Lee Ellis, *A Discipline in Peril: Sociology's Future Hinges on Curing Its Biophobia*, 27 AM. SOCIOLOGIST 21 (1996); John Tooby & Leda Cosmides, *The Psychological Foundations of Culture*, *in* THE ADAPTED MIND, *supra* note 1, at 19.

psychology precisely track the predictions of evolutionary biology.[104]

C. *Closing Remarks: Some Points to Take Away*

The relevance for lawyers of any given detail from the foregoing will vary according to the legal subdiscipline in which evolutionary analysis is invoked. For example, evolutionary influences on patterns of aggression will be more relevant to the criminal law, while influences on general patterns of sexuality will be more relevant to family law. But acquiring a general understanding of the processes of evolution, and of their inherently economic pressures upon heritable characteristics of living organisms, provides a necessary foundation for understanding the many causes, both proximate and ultimate, of human behavior.

For legal thinkers, the general evolutionary approach to understanding human psychology and behavior means several things. First, it is pointless to think in terms of "nature *versus* nurture." Asking whether a particular behavior is the product of nature (genetic influences) *or* of nurture (environmental influences) is like asking whether the area of a field is determined by its length *or* by its width.[105] It is necessarily a product of both. Neither nature nor nurture has any meaning, for any organism, except in concert with the other. Consequently, behavior, including human behavior, simultaneously can have—and usually does have—both proximate

104. *See* BUSS, *supra* note 98; HUMAN REPRODUCTIVE BEHAVIOUR: A DARWINIAN PERSPECTIVE (Laura Betzig et al. eds., 1988) [hereinafter HUMAN REPRODUCTIVE BEHAVIOUR]; HUMAN SPERM COMPETITION: COPULATION, MASTURBATION, AND INFIDELITY (R. Robin Baker & Mark A. Bellis eds., 1995); RIDLEY, *supra* note 65; TRIVERS, *supra* note 43, at 395-420 (discussing, in part, Ruben C. Gur & Harold A. Sackeim, *Self-Deception: A Concept in Search of a Phenomenon*, 37 J. PERSONALITY SOC. PSYCHOL. 147, 147-69 (1979)); WRIGHT, *supra* note 1; Browne, *Sex and Temperament*, *supra* note 3; Martin Daly & Margo Wilson, *Evolutionary Psychology and Family Violence*, *in* SOCIOBIOLOGY AND PSYCHOLOGY: IDEAS, ISSUES AND APPLICATIONS 293 (Charles Crawford et al. eds., 1987); Jones, *Reproductive Autonomy and Evolutionary Biology*, *supra* note 3, at 202-07 (reviewing evidence from humans consistent with Trivers-Willard Hypothesis on differential treatment of male and female offspring); Low, *supra* note 16; Margo Wilson & Martin Daly, *Competitiveness, Risk Taking, and Violence: The Young Male Syndrome*, 6 ETHOLOGY & SOCIOBIOLOGY 59 (1985).

105. Since at least the 1950s, many have labored to expose the absurdity of the dichotomy. *See, e.g.*, DONALD OLDING HEBB, A TEXTBOOK OF PSYCHOLOGY 195-96 (2d ed. 1966); Anne Anastasi, *Heredity, Environment, and the Question "How?,"* 65 PSYCHOL. REV. 197, 197 (1958); D.O. Hebb, *Heredity and Environment in Mammalian Behaviour*, 1 BRIT. J. OF ANIMAL BEHAVIOUR 43, 43-47 (1953). Unfortunately, it persists. For cogent attacks on its oversimplicity, see RIDLEY, *supra* note 65, at 175, 316-20 and Paul R. Abramson & Steven D. Pinkerton, *Introduction: Nature, Nurture, and In-Between*, *in* SEXUAL NATURE, SEXUAL CULTURE 1 (Paul R. Abramson & Steven D. Pinkerton eds., 1995) [hereinafter SEXUAL NATURE].

(immediate) *and* ultimate (evolutionary) causes.

Second, combinations of genes may "predispose" without rigidly "determining." It is precisely because evolutionary processes favored behavioral plasticity that (with the exception of reflexes and the like) genes do not determine our behavior as if we were "hard-wired" inevitably to respond to a certain stimulus with a single, corresponding act.[106] Instead, gene combinations can provide behavioral *propensities* that simply affect the *probability* that an organism bearing them will behave in some way. Stated differently: Evolutionary processes leave all organisms with many predispositions to respond to environmental stimuli in various fashions—but how strongly the predispositions affect behavior can vary quite widely among species, individuals, and circumstances.[107]

Third, some behavioral predispositions, including some human ones, are inherited according to definite rules. Because resources are finite at the same time that populations can grow exponentially, the relative proportions within a population of alternative inheritable predispositions are inevitably governed by a process of natural selection. That process tends to favor over time those among contemporaneously existing predispositions that more efficiently translate resources into reproduction. That is, when different inheritable predispositions unequally influence the reproductive success of the organisms bearing them (including the reproduction of genetic relatives), those predispositions tending to increase it by the greatest amount will tend to appear in increasing proportions of successive populations. Over many generations, alternative predispositions will tend to dwindle and disappear.

Fourth, the economic nature of such competition tends to yield heritable predispositions toward condition-dependent patterns of cooperation and conflict, as well as toward condition-dependent

106. Relatively unambiguous stimuli (like the arrival of food in the stomach or the rapid heating of skin) prompt automatic behavioral responses (like digestion or recoil) that free an organism to attend to other things. At the same time, even the most simple evaluative processes provide a distinct advantage over automatic responses when complex situations (such as an arrival at water) are encountered. Recognizing subtle and multiple differences in context then can divide beneficial responses (such as attempting to swim a pond) from disastrous ones (such as attempting to swim an ocean). The species-typical analytic abilities of our human brains evolved as surely as did the cranial capacity of the skull that shields them.

107. Moreover, the influence of genes on behavior, though often manifest, is rarely quantifiable with precision, like force, mass, or energy. Because there is no single gene "for" any complex human behavior, even the presence of genes that increase the likelihood of a behavior never guarantees that it will or will not occur. There is no more a single gene for "altruism," for example, than there is for a hand or face.

deception, self-deception, and counter-deception. At any given time, most organisms within a species will share certain evolved psychological mechanisms (with predictable variations as a function of such things as age and sex) that will predispose it toward behaviors that were, on average, adaptive for similarly situated organisms during the environment of evolutionary adaptation.

What all of this means for a legal system charged with governing human behavior is the subject of the next Part.

II. EVOLUTIONARY ANALYSIS IN LAW: A MODEL, AND ITS APPLICATION TO CHILD ABUSE

Learning more about modern evolutionary biology may help clarify *why* the discipline is inescapably relevant to the enterprise of law, but that will not alone show *how*. Consequently, this Part proposes a model for usefully employing evolutionary analysis in the pursuit of pre-articulated legal goals.[108] This Part is divided into four sections (see Figure 1) corresponding to the four stages of the model:

A. *The Identification Stage*
B. *The Information Stage*
C. *The Integration Stage*
D. *The Application Stage*

In brief, *The Identification Stage* frames the subject to analyze. It

108. There are at least two different approaches to such analysis. In the first, one looks to biology for insight regarding pre-identified law-relevant behavior. In the second, one learns of new developments in biology and subsequently considers aspects of law that might be affected. For example, new findings in biology will sometimes suggest reevaluation of assumptions that underlie the law's approach to common controversies. *See, e.g.*, Browne, *Sex and Temperament*, *supra* note 3 (arguing that the evidence for sex differences in evolved psychology undercuts policies predicated on the assumption that there are no differences between the sexes in evolved behavioral predispositions). Recent theoretical and empirical work, for example, strongly suggests that genes can and do influence the sexual orientation of many non-human and human animals. *See, e.g.*, DEAN HAMER & PETER COPELAND, THE SCIENCE OF DESIRE: THE SEARCH FOR THE GAY GENE AND THE BIOLOGY OF BEHAVIOR (1994); SIMON LEVAY, THE SEXUAL BRAIN (1993); Dean H. Hamer et al., *A Linkage Between DNA Markers on the X Chromosome and Male Sexual Orientation*, 261 SCI. 321 (1993); Simon LeVay & Dean H. Hamer, *Evidence for a Biological Influence in Male Homosexuality*, SCI. AM., Feb. 1994, at 44; Angela M.L. Pattatucci & Dean H. Hamer, *The Genetics of Sexual Orientation: From Fruit Flies to Humans*, *in* SEXUAL NATURE, *supra* note 105, at 154. This recommends reevaluation of those legal policies and doctrines that may be grounded in the theory that sexual orientation is determined solely by environmental factors or by choice. Because few legal academics read biology journals regularly, however, the model below is designed principally for the first approach.

clarifies one's legal goal with respect to a law-relevant aspect of human behavior and assesses the likelihood that evolutionary analysis can aid pursuit of that goal. *The Information Stage* uncovers and organizes new information on the multiple causes of the defined behavior. It describes how one can explore evolutionary theories, examine the evidence bearing on their falsifiable predictions, assess the fit between theory and evidence, evaluate robust theories' applicability in the human context, and decide whether to include any specific evolutionary theory in the decision-making processes by which law pursues the pre-determined goal. For those evolutionary theories worthy of such inclusion, *The Integration Stage* describes how to expose true conflicts between evolutionary and prevailing theories and how to integrate the best parts of each in furtherance of a more accurate and comprehensive understanding of the behavior. *The Application Stage* then applies the information generated by the previous stages to effect concrete improvements in the legal system. It describes how one can refine behavioral models underlying law's treatment of the behavior, generate new legal strategies for pursuing pre-articulated legal goals, improve the cost-benefit analyses that often drive various legal policies, and provide new directions for future research initiatives.

The advantage of this model, which partly parallels the scientific method of evaluating multiple causal hypotheses, is that it provides sufficient methodological guidance that anyone with the interest could apply evolutionary analysis to contemporary legal issues. The remainder of this Article explores this model in detail and shows, for each step of the analysis, a practical application of the model—in this case, to aspects of the problems raised by child abuse.

FIGURE 1: Evolutionary Analysis in Law: A Model

I. THE IDENTIFICATION STAGE: ON PURPOSE AND PROCESS
- A. *What is the Legal Goal?*
- B. *Will Evolutionary Analysis Further Pursuit of That Goal?*
  1. What Are the Prevailing Theories?
  2. Is the Failure to Achieve the Goal Solely Attributable to Inadequate Implementation of Adequate Theories?
  3. Are the Prevailing Theories Already Informed by the Influence of Natural Selection on Behavior?
  4. How Greatly Might the Behavior in Question Have Affected the Reproductive Success of Our Ancestors?

II. THE INFORMATION STAGE: ON THEORIES AND EVIDENCE
- A. *What Are the Relevant Evolutionary Theories and Predictions?*
- B. *What Empirical Evidence Bears on Those Predictions?*
- C. *How Does the Evidence Fit the Predictions?*
- D. *Do the Theories Apply to Humans?*
- E. *Should the Theories Be Considered in Legal Analysis and Policy-Making?*

III. THE INTEGRATION STAGE: ON CONFLICTS AND COMPATIBILITIES
- A. *Where Do Prevailing and Evolutionary Theories Conflict?*
  1. Conflicts Between Theoretical Substructures
     a. Levels of Analysis
     b. Basic Assumptions
  2. Conflicts Between Predictions
- B. *How May Non-Conflicting Elements Be Integrated?*

IV. THE APPLICATION STAGE: ON UTILITY
- A. *How Can Evolutionary Analysis Help to Refine Behavioral Models?*
  1. Emphasizing Both Proximate and Ultimate Causation
  2. Revealing New Associated Environmental Factors ("AEFs")
  3. Restating Prior AEFs More Precisely
  4. Predicting Interactions of AEFs
- B. *How Can Evolutionary Analysis Help to Generate New Legal Strategies?*
  1. New Strategies for Newly Identified AEFs
- C. *How Can Evolutionary Analysis Help to Improve Cost-Benefit Analyses?*
  1. Identifying Policy Conflicts
  2. Clarifying Costs of Conflicts
- D. *How Can Evolutionary Analysis Help to Reveal Promising Directions for Future Research?*
  1. New Ways to Collect and Slice Data
  2. Further Study of Multiple Evolutionary Theories
  3. Further Research to Test Conflicting Predictions

A. *The Identification Stage*

The first stage of the model, *The Identification Stage*, is straightforward and preparatory. Its purpose is to answer two questions: 1) What is the legal goal?; and 2) Will evolutionary analysis further pursuit of that goal?

1. What Is the Legal Goal?

There are many different ways to identify a legal goal.[109] Regardless of the route taken, however, it is important at the outset of most evolutionary analysis in law to define a legal goal in terms of specific human behaviors, the incidence of which law is asked to increase or decrease.[110] Employing this approach, for example, reveals drunk driving as an impediment to society's quest for reasonably safe highways, and clarifies how child abuse obstructs efforts to secure unimpeded child health. Successfully framing a legal goal in a fashion conducive to later evolutionary analysis simply requires that one specify a preference for law's relationship with or general orientation toward the defined behavior. Thus, for example, law should specifically help to *reduce* drunk driving or to *reduce* child abuse (though not, of course, at any cost).[111]

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109. For some people, legal goals spring spontaneously to mind. "Reducing drunk driving" or "reducing child abuse" are examples. For other people, legal goals are only remote subsets of larger areas of concern, discoverable through a winnowing process that moves hierarchically from issue to objective to physical and social conditions to goals. People tending to think in this way, for example, may initially be concerned about entire issues, such as "public safety" or "child welfare," each of which may have many possible legal dimensions. And within those issues, they could state multiple normative objectives worth society's pursuit, such as "secure homes" and "safe highways," on one hand, or "adequate schooling" and "healthy children," on the other. These objectives, in turn, impliedly divide observable environmental conditions, such as prevalent social behaviors, according to their consistency or inconsistency with those objectives. And this process leads logically to legal goals that reflect a shared sense of what law should do about the incidence of those conditions. Policymakers are then charged with selecting and implementing legal strategies to pursue those goals.

110. It is theoretically possible to define the behavior in terms of the psychological states typically associated with it. For example, if one is interested in reducing the incidence of excessive speeding, one might define the goal in terms of decreasing the incidence of the psychological discounting of the probability that one will receive or inflict injury as a consequence of speeding. On common errors in assessing probabilities, for example, see JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES (Daniel Kahneman et al. eds., 1991).

111. Legal goals can be equivalently worded in the affirmative or negative. "Reducing drunk driving" is a flip side to "increasing the incidence of careful and responsible driving." In addition, sensitivity to various economic considerations, such as the opportunity cost of all investment efforts, might recommend framing the goal more explicitly in cost-benefit terms. For example: To minimize the sum of both the costs of child abuse and the

Although any number of goals might usefully serve, let us demonstrate this aspect of the model by designating "the reduction of child abuse" as our legal goal.[112] The many legal regimes that address child abuse, as well as the media's daily attention to the subject, already reflect widespread public concern.[113] Although attempts to

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costs of measures to prevent child abuse.

112. Although child abuse encompasses an enormous range of acts, both of commission and omission, it should be understood that the term, as used here, will primarily refer to non-sexual physical abuse or proscribed neglect by genetic parents or parent substitutes, such as stepparents. Child abuse yields no universally accepted definition, in part, because of ambiguities inherent in such terms as "severe" and "chronic." Because ensuring a child's welfare requires adequate and safe gestation, birth, physical growth, emotional growth, and education, however, we generally categorize as "child abuse" any human behavior that substantially impedes or harms a child during any of these developmental stages. These include, for example, physical battering, physical endangerment, physical neglect, medical neglect, sexual abuse, sexual exploitation, emotional abuse, developmental neglect, improper ethical supervision, educational neglect, and abandonment. *See* Douglas J. Besharov, *"Doing Something" About Child Abuse: The Need to Narrow the Grounds for State Intervention*, 8 HARV. J.L. & PUB. POL'Y 539, 589 app. (1985); *see also* David Finkelhor & Jill Korbin, *Child Abuse as an International Issue,* 12 CHILD ABUSE & NEGLECT 3, 4 (1988) (defining child abuse as "the portion of harm to children that results from human action that is proscribed, proximate, and preventable" (emphasis omitted)). Some researchers subdivide maltreatment into acts of commission (abuse) and omission (neglect), while others categorize maltreatment with reference to presence or absence of perpetrator intent or to violation of cultural norms. *See* PANEL ON RESEARCH ON CHILD ABUSE AND NEGLECT, NATIONAL RESEARCH COUNCIL, UNDERSTANDING CHILD ABUSE AND NEGLECT 4-5, 57-72 (1993) (summarizing the variety of definitions) [hereinafter UNDERSTANDING CHILD ABUSE AND NEGLECT]; Richard J. Gelles, *Problems in Defining and Labeling Child Abuse*, *in* CHILD ABUSE PREDICTION: POLICY IMPLICATIONS 1, 1-29 (R.H. Starr ed., 1982) (noting how definition varies by profession); *see generally* OLIVER C.J. TZENG ET AL., THEORIES OF CHILD ABUSE AND NEGLECT: DIFFERENTIAL PERSPECTIVES, SUMMARIES, AND EVALUATIONS 7-8 (1991) (explaining definitional approaches) [hereinafter TZENG ET AL., THEORIES OF CHILD ABUSE AND NEGLECT] and sources cited therein. The federal government uses different definitions in different contexts, and definitions also vary from state to state in both public and private arenas and in professional disciplines. *See* Robert T. Ammerman & Michel Hersen, *Research in Child Abuse and Neglect: Current Status and an Agenda for the Future* [hereinafter Ammerman & Hersen, *Research in Child Abuse and Neglect*], *in* CHILDREN AT RISK: AN EVALUATION OF FACTORS CONTRIBUTING TO CHILD ABUSE AND NEGLECT 3, 6 (Robert T. Ammerman & Michel Hersen eds., 1990) [hereinafter CHILDREN AT RISK]; TZENG ET AL., THEORIES OF CHILD ABUSE AND NEGLECT, *supra*, at 7. Although child sexual abuse is not less susceptible of evolutionary analysis, it is susceptible of a different evolutionary analysis than the examples used below.

113. Although adults have abused children throughout history, see Ruth E. Holland, *Children in Peril: Historical Background*, *in* SOURCEBOOK FOR CHILD ABUSE AND NEGLECT: INTERVENTION, TREATMENT AND PREVENTION THROUGH CRISIS PROGRAMS 39, 39-52 (Oliver C.S. Tzeng & Jamie Jasper Jacobsen eds., 1988), child maltreatment was not a subject of serious study until the 1960s, when an article by several pediatricians introduced the term "battered child syndrome." C.H. Kempe et al., *The Battered Child Syndrome,* 181 JAMA 105 (1962). Congress subsequently passed the first Child Abuse Prevention and Treatment Act in 1974, and amended it several times through 1994. *See* Child Abuse Prevention and Treatment Act, Pub. L. No. 93-247, 88

measure the significance of the problem vary by year and methodology, in 1989 alone there were at least 160,000 reported incidents of abuse leading to the death or serious injury of a child,[114] as well as more than two million additional reports of significant child maltreatment.[115]

There are at least two reasons why the legal goal should be articulated this early in evolutionary analysis. First, analysis rarely fails to benefit from the guidance of a pervasive, focused sense of purpose. Second, and even more important, the early association of a specific goal with a behavior minimizes the extent to which subsequent analysis could, even unintendedly, encroach upon the normative functions properly reserved to other political processes. Critics of those who invoke biology as policy-relevant, for example, almost reflexively fear

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Stat. 4 (codified as amended at 42 U.S.C. §§ 5101-05 (1994)). The Act established a program to guide and consolidate national and state data collection efforts, conduct national surveys concerning household violence, and sponsor research to identify, prevent, and treat child abuse and neglect. *See id.; see also* DONALD T. KRAMER, 2 LEGAL RIGHTS OF CHILDREN §§ 16.01-.33 (2d ed. 1994) (providing overview of legal aspects of child abuse prevention programs). The 1988 Amendments established the U.S. Advisory Board on Child Abuse and Neglect. *See* Child Abuse Prevention and Treatment Act, Pub. L. No. 100-294, 102 Stat. 103 (codified as amended at 42 U.S.C. § 5102). An example of such data collection appears in NATIONAL CENTER ON CHILD ABUSE PREVENTION RESEARCH, NATIONAL COMM'N FOR PREVENTION OF CHILD ABUSE, CURRENT TRENDS IN CHILD ABUSE REPORTING AND FATALITIES: THE RESULTS OF THE 1995 ANNUAL FIFTY STATE SURVEY (1996) [hereinafter CURRENT TRENDS IN CHILD ABUSE REPORTING AND FATALITIES].

114. *See* INGER J. SAGATUN & LEONARD P. EDWARDS, CHILD ABUSE AND THE LEGAL SYSTEM 4-6 (1995); *see also* NATIONAL CTR. ON CHILD ABUSE PREVENTION RESEARCH, NATIONAL COMM. FOR PREVENTION OF CHILD ABUSE, CURRENT TRENDS IN CHILD ABUSE REPORTING AND FATALITIES: THE RESULTS OF THE 1990 ANNUAL FIFTY STATE SURVEY (1991) [hereinafter 1990 SURVEY] (summarizing recent findings).

115. *See* UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 38, 78-85. Although reporting statistics provide only a loose estimate of actual incidence, researchers generally agree that reported cases represent only the "tip of the child abuse iceberg" (because not all abuse is reported and not all reports are substantiated). Raymond H. Starr, Jr. et al., *The Epidemiology of Child Maltreatment, in* CHILDREN AT RISK, *supra* note 112, at 23, 29; *accord* MURRAY A. STRAUS ET AL., BEHIND CLOSED DOORS: VIOLENCE IN THE AMERICAN FAMILY 6 (1980). A 1995 Gallup Poll suggests that the actual number of children physically abused each year may exceed three million—more than 16 times the number officially reported to the National Center on Child Abuse and Neglect. *See* Tamar Levin, *Parent Poll Shows Higher Incidence of Child Abuse*, N.Y. TIMES, Dec. 7, 1995, at B16.

The General Accounting Office estimated in 1991 that, excluding the expenses of agencies charged with detecting child abuse, the cost of services for abused children, including medical care, family counseling, foster care, and specialized education, currently exceeds five hundred million dollars annually. *See* U.S. GENERAL ACCOUNTING OFFICE, CHILD ABUSE PREVENTION: STATUS OF THE CHALLENGE GRANT PROGRAM 1 (1991). And according to more recent reports, the federal government alone now contributes four billion dollars a year to state child protection services. *See* Robert Pear, *Many States Fail to Meet Mandates on Child Welfare*, N.Y. TIMES, Mar. 17, 1996, at A1.

(and not entirely without reason) the kind of encroachment into norm-formulation made famous by the Social Darwinists of the 1870s and 1880s who had reasoned: What *is*, in nature, *ought* to be.[116] Because such illegitimate blending of descriptive and normative processes is possible (though not inevitable), securing a pre-articulated goal this early may both vindicate and alleviate critics' concerns that an amoral biology will supply any normative goal to legal policymaking.[117] An early goal provides some assurance that one will not later let the tail wag the dog—by perhaps reaching the absurd result that "other animals, too, abuse their offspring *and therefore* child abuse is allowable."

2. Will Evolutionary Analysis Further Pursuit of That Goal?

With goal in hand, we must assess whether a full and rigorous evolutionary analysis will be worth the effort. That is: Will evolutionary analysis further pursuit of the specified goal? Answering this larger question requires, in sequence, that one briefly answer four subordinate queries: a) What are the prevailing theories?; b) Is the failure to achieve the goal solely attributable to inadequate implementation of adequate theories?; c) Are the prevailing theories already informed by the influence of natural selection on behavior?; and d) How greatly might the behavior in question have affected the reproductive success of our ancestors?

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116. *See, e.g.*, SOCIAL DARWINISM: SELECTED ESSAYS OF WILLIAM GRAHAM SUMNER (1963). On Social Darwinism generally, see HOFSTADTER, *supra* note 47. For an example of reaction (now dated) to sociobiological thinking that reflects important concerns regarding potential misuses of biology, see MARSHALL SAHLINS, THE USE AND ABUSE OF BIOLOGY: AN ANTHROPOLOGICAL CRITIQUE OF SOCIOBIOLOGY (1976).

117. Many have argued that one commits the "naturalistic fallacy" whenever contending that a description from biology (an "is") can alone imply a normative conclusion in law (an "ought to be"). *See, e.g.*, DAVID A. HUME, TREATISE OF HUMAN NATURE 469-70 (L.A. Selby-Bigge & P.H. Nidditch eds., 2d ed. 1978) (making famous, in the original 1888 edition, the "no is to ought" formulation); G.E. MOORE, PRINCIPIA ETHICA 62, 89-110 (Thomas Baldwin ed., 2d ed. 1993) (coining "naturalistic fallacy" and using Social Darwinist Herbert Spencer as an example); *see also* JAMES RACHELS, CREATED FROM ANIMALS: THE MORAL IMPLICATIONS OF DARWINISM 62-79 (1990) (discussing the naturalistic fallacy). *But see* LEWIS PETRINOVICH, HUMAN EVOLUTION, REPRODUCTION AND MORALITY 23-42 (1995) (arguing "is" importantly influences, without itself determining, "ought"); MICHAEL RUSE, TAKING DARWIN SERIOUSLY: A NATURALISTIC APPROACH TO PHILOSOPHY 207-72 (1986) (arguing that Darwinian theory has some utility in enriching our understanding of morality); Strahlendorf, *Evolutionary Jurisprudence*, *supra* note 3 (thoughtfully probing potential normative implications of natural selection); Peter Strahlendorf, *An Evolutionary Theory of the Good: Is the Mind Designed to Sense Fundamental Categories of the Good?*, 1 RECHT UND VERHALTEN 249 (1994) (same).

a. What Are the Prevailing Theories?

This first step in assessing the potential utility of evolutionary analysis in law requires one to identify prevailing theories that purport to explain the behavior that impedes access to the legal goal. One cannot logically expect to influence the incidence of a behavior without a working theory of the sorts of things that affect it; evolutionary analysis will prove useful only if it holds some promise to provide something that existing theories cannot.

Because this aspect of *The Information Stage* requires only a preliminary determination of whether or not to expend further efforts in evolutionary analysis, it is unnecessary to detail or canvass exhaustively every existing theory on the behavior. It is instead sufficient to establish a general frame of reference by identifying and describing the prevailing theories' larger features, common thematic underpinnings, and general orientations toward the behavior under study. A prevailing theory might, for example, locate the primary causes of a given, law-relevant behavior in childhood trauma, drug abuse, insufficiently developed social skills, economic stratification, racial tensions, personality disorders, and the like, or in some complex interplay of these.

In the context of child abuse, for example, the dozens of separate theories that purport to explain its incidence sort loosely into four models:

- The *Psychopathology Model* blames child abuse on parental psychiatric disturbance or mental illness (such as sadism). It suggests that child abuse is but one manifestation of parental psychodynamic dysfunction or personality disorder, in which a parent's unmet emotional needs and expectations yield either impulsive aggressiveness or an inability to care properly for a child.
- The *Social-Cultural Model* emphasizes the contributions of social and cultural forces (such as economic hardship or culturally permissible physical punishment). It suggests that child abuse results when sociodemographic stressors meet abuse-permissive cultural, community, and family socialization.
- The *Social-Interactional Model* scrutinizes each abusive parent-child relationship in its dynamic social context. Process-oriented, it suggests that child abuse is a function of interplay between the unique characteristics of parent *and child*, against a background that includes past and present events

that each experiences.

- The *Transitional Model* builds upon these others, but places greater emphasis on the very gradual process by which factors contributing to the likelihood of abuse develop ("transition") into an abusive situation. It suggests that child abuse can result when "destabilizing factors" initiate a multistage process in which child abuse follows from reduced stress-tolerance and mishandled provocations.[118]

These prevailing theories are quite well-developed and distinct.[119] They reflect the extraordinary diligence of many scholars and practitioners deeply committed to understanding and reducing child abuse. Despite the apparent differences among them, however, they do illustrate several of the many kinds of foundational commonalities and thematic underpinnings that may usefully be noted, when present, among prevailing theories.

First, for example, these prevailing theories are all skewed powerfully toward the present tense, focusing on a very narrow slice of our species' behavioral history. They generally reflect an implicit assumption that anything that happened before the birth of an individual (or of her parents) is irrelevant to understanding abusive behavior. Those that do glance back in time, as to the emergence of social mores or familially linked psychopathologies, typically probe no deeper than a few generations back. Second, the theories are strongly slanted toward individual persons, individual environments, and even individual countries, typically presupposing that the behavior of an abusive individual can be best understood by studying

118. *See* DAVID A. WOLFE, CHILD ABUSE: IMPLICATIONS FOR CHILD DEVELOPMENT AND PSYCHOPATHOLOGY 44-68 (1987); Robert T. Ammerman, *Predisposing Child Factors, in* CHILDREN AT RISK, *supra* note 112, at 199, 199-202. The first three of these models are the most traditional. For greater detail, see TZENG ET AL., THEORIES OF CHILD ABUSE AND NEGLECT, *supra* note 112, at 10-200 (grouping 46 separate theoretical viewpoints into nine paradigms, describing individual theories, summarizing different theoretical views, and evaluating the current status of child abuse theories); Robert T. Ammerman & Michel Hersen, *Research in Child Abuse and Neglect: Current Status and an Agenda for the Future, in* CHILDREN AT RISK, *supra* note 112, at 3 (summarizing the history of research on child maltreatment).

119. These four categories can hardly capture the full sophistication of and variation among all the theories of child abuse. Nonetheless, it seems clear that other nonevolutionary theories are sufficiently similar to the prevailing theories here overviewed to be treated similarly in discussions that follow. *See, e.g.*, TZENG ET AL., THEORIES OF CHILD ABUSE AND NEGLECT, *supra* note 112, at 11; Jay Belsky, *Child Maltreatment: An Ecological Integration,* 35 AM. PSYCHOL. 320, 320-32 (1980); Robert Fiala & Gary La Free, *Cross-National Determinants of Child Homicide,* 53 AM. SOC. REV. 432, 433-35 (1988) (dividing factors that contribute to child abuse into: 1) economic stress; 2) social disorganization; 3) culture of violence; and 4) social isolation and surveillance).

only the characteristics, experiences, and social environments of *that* individual. They therefore fail to inquire into species-wide behavior and thereby often amplify, even if unintendedly, the importance of individual psyches over naturally selected behavioral predicates. Third, the prevailing theories are biased by an anthropocentric species isolationism, as reflected in the absence of any meaningful consideration of "abusive" behavior in other creatures. And fourth, the theories presuppose that, in the absence of genetic pathology or defect, naturally selected genes have no palpable influence on the behavior of individuals; abusive behavior is socially constructed.

These are precisely the kinds of commonalities, which might at first seem to be trivial truths, that will be critical to an understanding of how evolutionary analysis can improve a legal system. While they do not render the theories incorrect or unhelpful, they do suggest an overemphasis on immediate causes at the expense of concurrent and equally significant evolutionary causes.

b. Is the Failure to Achieve the Goal Solely Attributable to Inadequate Implementation of Adequate Theories?

One asks this question to preclude an unexamined assumption that the prevailing theories are *necessarily* inadequate. An unmet goal can be the result of two separate phenomena, or a combination of both: 1) inadequate theories (including an absence of any theory) on what causes the behavior; and 2) inadequate *implementation* of adequate theories. It is possible that prevailing theories perfectly predict the behavior, even though the means to effect change with that knowledge escapes us.

Is the failure to reduce child abuse solely attributable to inadequate implementation of adequate theories? Probably not.[120] Behavioral theories, at least those concerning humans, rarely predict behavior so consistently as to preclude improvement. Reports of physical abuse doubled between 1980 and 1990,[121] despite the blossoming of several dozens of theories on the causes of maltreatment and the proliferation of counteractive programs. Indeed, researchers

120. The U.S. Advisory Board on Child Abuse and Neglect refers to child maltreatment as "epidemic," requiring a critical national emergency response. *See* UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 42. It is generally agreed that "existing models are inadequate." *E.g.*, Roy C. Herrenkohl, *Research Directions Related to Child Abuse and Neglect, in* CHILDREN AT RISK, *supra* note 112, at 85, 91.

121. *See* TZENG ET AL., THEORIES OF CHILD ABUSE AND NEGLECT, *supra* note 112, at 5. Although the doubling of *reports* may provide little reliable evidence of the actual rate of abuse, it at least indicates that child abuse has not disappeared.

conclude that the prevalence of child abuse has increased significantly in recent years.[122] Although existing theories *also* may be inadequately implemented, warranting our constant and close attention, the continued prevalence of child abuse in the face of widespread efforts to curtail it strongly suggests that these theories can be improved.[123]

c. Are the Prevailing Theories Already Informed by the Influence of Natural Selection on Behavior?

An affirmative answer to this question, though not precluding further refinement of theory, suggests there may be less potential in evolutionary analysis than when prevailing theories reflect no recognition of behavioral evolution. Because evolutionary analysis has only recently begun to illuminate human behavioral models in a systematic fashion,[124] however, this question will generally be answered in the negative for the near future.

The prevailing theories on child abuse, for example, if anything, reflect an environmental determinism in which nearly all abusive behavior (with the possible exception of genetically influenced mental illness) is the result of post-birth, directly experienced, social and cultural phenomena.[125] A recent book devoting 300 pages to factors that contribute to child abuse, for example, neither mentions nor reflects recognition of evolutionary influences on human behavior.[126] Fur-

122. *See, e.g., id.* at xv.

123. *See, e.g.*, UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at v-vi:

> [D]aunting obstacles inhibit the scientific study of this topic: the nature of the subject itself is emotionally overwhelming, the field lacks consistent definitions and valid instrumentation, data collection efforts are cumbersome and often unreliable, and the presence of multiple cofactors in the study populations—including poverty, violence, and other forms of victimization—makes it exceedingly difficult to isolate key factors.

124. *See, e.g.*, THE ADAPTED MIND, *supra* note 1; JEROME H. BARKOW, DARWIN, SEX, AND STATUS: BIOLOGICAL APPROACHES TO MIND AND CULTURE (1991); DALY & WILSON, HOMICIDE, *supra* note 98.

125. *See, e.g.*, WOLFE, *supra* note 118, at 24 ("Child-rearing practices are influenced by numerous cultural and situational factors that determine the level of conflict or cooperation in the emerging parent-child relationship ... [and] families become socialized into abusive patterns of child treatment."). Various causal models propose that child abuse is primarily a function of personality disorders, having been abused oneself, disruptions in parent-child attachment, inappropriate parental expectations, frustration due to stress, inadequate social supports, child temperamental or behavioral deviance, and the "sociocultural milieu." *See, e.g.*, Herrenkohl, *supra* note 120, at 89-92; Joan I. Vondra, *Sociological and Ecological Factors*, *in* CHILDREN AT RISK, *supra* note 112, at 149, 150, 162-63.

126. *See* CHILDREN AT RISK, *supra* note 112. There are notable exceptions. *See, e.g.*, DAVID POPENOE, LIFE WITHOUT FATHER: COMPELLING NEW EVIDENCE THAT

thermore, a 1993 summary of the last three decades of child abuse research observed that modern models have advanced from single-factor explanations to "multicausal interactive models, which emphasize the importance of the *sociocultural context* of child maltreatment."[127] The conspicuous absence from the prevailing theories of any mention of human evolution, or of evolved behavioral predispositions of any kind, reflects a passive and unexamined assumption that, absent genetic defects, human behavior simply is not significantly influenced by the cumulated effects of natural selection on our species.[128] Indeed, the 1993 report of the National Research Council's Panel on Research on Child Abuse and Neglect illustrated the pervasiveness of this assumption when listing only "medicine (especially pediatrics and psychiatry), psychology, social work, criminal justice, law, sociology, public health, nursing, anthropology, demography, statistics, and education" as the "disciplines and subject areas [that] contribute[] to studies of child maltreatment."[129]

FATHERHOOD AND MARRIAGE ARE INDISPENSABLE FOR THE GOOD OF CHILDREN AND SOCIETY 70-73, 165-73 (1996); Richard J. Gelles & John W. Harrop, *The Risk of Abusive Violence Among Children with Nongenetic Caretakers*, 40 FAM. REL. 78, 78-83 (1991) (squarely confronting biosocial theories); Michael T. McGuire & Richard Gelles, *Family Violence, Evolutionary Biology, and the Law in* GEWALT IN DER KLEINGRUPPE UND DAS RECHT, 3 FESTSCHRIFT MARTIN USTERI, SCHRIFTEN ZUR RECHTSPSYCHOLOGIE, at 1 (forthcoming 1997); David Popenoe, *The Evolution of Marriage and the Problem of Stepfamilies: A Biosocial Perspective, in* STEPFAMILIES: WHO BENEFITS? WHO DOES NOT? 3 (Alan Booth & Judy Dunn eds., 1994) [hereinafter STEPFAMILIES].

127. UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 107 (emphasis added); *see also id.* at vi, 7-10 (discussing the progress in research and development of etiological models).

128. *See, e.g., id.* at 54 ("Although the pathogenic model remains popular among the general public in explaining the sources of child maltreatment. . . . [r]esearch investigators now recognize that individual behaviors are often influenced by factors within the family, community, and society as a whole.").

129. *Id.* at 23; *see also* Vondra, *supra* note 125, at 149-50 (suggesting interdisciplinary child abuse work draws only on sociology, developmental psychology, clinical psychology, and the "family disciplines"). The panel was created at the request of the Commissioner of the Administration for Children, Youth, and Families (ACYF) of the U.S. Department of Health and Human Services. Its mission was to "[r]eview and assess research on child abuse and neglect, encompassing work funded by ACYF and other known sources under public and private auspices; [i]dentify research that provides knowledge relevant to the field, and [r]ecommend research priorities for the next decade." UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 3. Most notably, the final product mentions and dismisses possible evolutionary influences in a single paragraph—which evidences a jaw-dropping misunderstanding of even the simplest tenets of evolutionary theory. *See id.* at 122 (grossly mischaracterizing current evolutionary theory as concerned with genetic factors that "enhance the chances of survival of the species").

d. How Greatly Might the Behavior in Question Have Affected the Reproductive Success of Our Ancestors?

This fifth and final question is the most important. The *extent* to which an evolutionary perspective will be useful in regulating a behavior will vary as a function of the extent to which consequences of that behavior, as well as of alternative behaviors, bore on individual reproductive success in deep ancestral environments.[130] Greater effects suggest greater utility. For even though all behaviors are played through bodies and brains natural selection has helped to shape, not all behaviors are susceptible of truly useful evolutionary analysis. Estimating those effects requires a thorough understanding of the details, themes, and theories set forth above in Part I.[131]

To what extent, for example, might child abuse have affected the reproductive success of our ancestors? A great deal. Generating offspring and contributing toward their eventual reproduction represent the essence of the process by which genes in humans replicate themselves. Because *Homo sapiens sapiens* is a species that has long exhibited a reproductive strategy requiring high parental care, the rearing of offspring is absolutely central to the offspring's success in the gene-replication process. Activities that affect offspring-rearing, such as neglecting, abusing, or killing an offspring, are therefore paradigmatic issues on which an evolutionary analysis could probably provide great insight.[132] Under the incessant pressure of natural selection, these activities are unlikely to have had a neutral effect on reproductive success. Consequently, the absence of any meaningful evolutionary backdrop to prevailing theories on the causes of child abuse, as well as the likelihood that abusive behavior would powerfully affect reproductive success, makes the goal of reducing child abuse an exemplar of one that justifies further evolutionary analysis.

130. A more precise, though more cumbersome way of phrasing the question is: To what extent might a genetically heritable psychological mechanism that increased the probability of the defined behavior during the environment of evolutionary adaptation have contributed to the reproductive success of its bearer more than contemporaneously existing alternative psychological mechanisms?

131. Depending on how the behavior has been defined, estimating its likely effect on ancestral reproductive success may require further specificity. For example, it is far easier to estimate the effects of "risk-taking" behavior by ancestors than of their "driving too fast." When such a circumstance obtains, it may be necessary to redefine the behavior, breaking it down into more basic elements that are more easily susceptible of evolutionary analysis—elements that are more generalizable constituents of the behavior as originally framed.

132. Other paradigmatic issues include those invoking human sexuality, courtship, cooperation, aggression, and the like.

3. Summary

In sum, this *Identification Stage* provides an outline for beginning evolutionary analysis in law. Asking "What is your legal goal?" helps to shape an inquiry by defining terms and clarifying purposes. Asking "Will evolutionary analysis further pursuit of that goal?" prompts a careful assessment of whether to undertake that analysis in the first place. To demonstrate how these questions might be answered in a specific context, this section introduced an example concerning the legal goal of reducing child abuse, and concluded that continued evolutionary analysis was indeed likely to aid that effort. As it did in this first stage, the child abuse example will continue to illustrate the explanations of each successive stage of the model for evolutionary analysis in law.

B. The Information Stage

When evolutionary analysis shows some promise of utility, one must identify specific evolutionary theories that purport to illuminate the "ultimate" (rather than simply "proximate"[133]) influences on the defined behavior and then assess each theory's merit. Scientific method measures the merit of each theory by straining the falsifiable predictions it generates with the weight of empirical evidence. Because robust theories bear that strain, the second stage of the proposed model of evolutionary analysis, *The Information Stage*, will consist of five subordinate questions: 1) What are the relevant evolutionary theories and predictions?; 2) What empirical evidence bears on those predictions?; 3) How does the evidence fit the predictions?; 4) Do the theories apply to humans?; and 5) Should the theories be considered in legal analysis and policy-making?

This section explains the methodological basis for each of these questions. By tracing a sample problem from child abuse through each question in succession, this section also demonstrates how evolutionary theory can, in ways relevant to law, both reveal and make sense of surprising patterns in human behavior, such as child-killing. The third question, involving empirical evidence, is the most fact intensive to demonstrate, and will require somewhat lengthier examination below than will the other questions.

133. These terms of art, used differently in biological than in legal contexts, are explained *supra* notes 15-20 and accompanying text.

1. What Are the Relevant Evolutionary Theories and Predictions?

In its largest sense, "evolutionary theory" is a general level theory that explains the existence and persistence of organism characteristics as the result of natural selection.[134] Like many such metatheories, its logic begets mid-level theories or operational principles, like those of "sexual selection," "parental investment," and "competition for resources," that address entire domains of organismic functioning. These in turn beget more specific theories (or "hypotheses") that purport to explain increasingly specific patterns of behavior. While there is no absolute limit to the taxonomy of subtheories and sub-sub-theories, one eventually reaches a workably specific theory that generates extremely narrow predictions of what should be testable and observable if that theory is robust.[135] The first step of *The Information Stage* entails examining those subtheories of evolutionary theory that may illuminate ultimate causes of the behavior under study.

Because there can be multiple evolutionary influences on behaviors (such as aggression, for example), this step of *The Information Stage* ordinarily will require first identifying and understanding the broad evolutionary and thematic contexts in which the behavior operates. It subsequently will entail the particularized application of specific evolutionary theories to the behavior itself. This, in turn, may involve research into the vast stores of evolutionary knowledge and theoretical work currently under development in evolutionary psychology, evolutionary anthropology, and the like, as well as deriving new theories from the basic principles of evolutionary biology, undertaking new empirical research, or both.[136]

Because a theory is only as valuable as the accuracy of the predictions it generates, this step of *The Information Stage* will also

134. *See* Buss, *supra* note 1, at 2-4.

135. So that it may be clear, this is the layer of theories, where specific predictions are generated, to which this Article henceforth refers when it speaks of "evolutionary theories" or "specific evolutionary theories" (except where context may otherwise require).

136. At this point, research might again suggest that the behavior as it was originally framed for study in the *Identification Stage* may usefully be divided into logically separable subunits, and the subsequent analysis may be refocused accordingly. The analysis of aggressive male behavior, for example, might usefully be separated into that concerning aggression toward other males and that concerning aggression toward females, because research and theory suggests these phenomena have different explanations. *See, e.g.*, Martin Daly & Margo Wilson, *Evolutionary Psychology of Male Violence*, *in* MALE VIOLENCE 253, 268-69 (John Archer ed., 1994) (contrasting male-male violence with male-female violence); Barbara Smuts, *Male Aggression Against Women: An Evolutionary Perspective*, 3 HUM. NATURE 1 (1992) (discussing male-female aggression among primates).

require, following study of each theory, the enumeration of specific, narrow, and falsifiable predictions of the non-random patterns of human behavior that should be obvious in the evidence if a given theory (or hypothesis) is a good one.

a. The Evolutionary Theories: An Example

Space limits the comprehensive exploration here of *all* evolutionary theories concerning what we might, in the non-human context, simply call "harming juveniles." For the limited purpose of demonstrating the model, however, we may narrow our focus (for the first of several times) to explore one *subset* of harms to juveniles: Infanticide.[137] The topic has been well studied, and the unambiguity of death precludes interpretive complications surrounding cross-species definition of "abuse" or "harm." Additionally, infant killing is surprisingly common among human populations. Very conservative estimates of infanticide rates in the United States, for example, range from about three to thirteen abuse-related infant deaths per day,[138] making abuse the leading cause of trauma death for young

137. Definitions of infanticide in the human context vary as a function of the intentionality of the act, the age of the child, and (for some) the prevailing cultural norms regarding child-rearing and child-killing. *Compare* William L. Langer, *Infanticide: A Historical Survey*, 1 HIST. CHILDHOOD Q. 353, 353 (1974) (infanticide defined to require wilfulness), *with* Laila Williamson, *Infanticide: An Anthropological Analysis*, *in* INFANTICIDE AND THE VALUE OF LIFE 61, 63 (Marvin Kohl ed., 1978) (classifying fatal neglect as infanticide). For the purposes of this Article, both ultimate and proximate causation is relevant, so intentionality will not be an element of infanticide.

While the majority view appears to be that lethal child abuse and non-lethal physical abuse exist on the same continuum of violence, some have argued to the contrary. *Compare* Gelles & Harrop, *supra* note 126, at 82 (challenging majority view), *with* Martin Daly & Margo Wilson, *A Reply to Gelles: Stepchildren* Are *Disproportionately Abused, and Diverse Forms of Violence* Can *Share Causal Factors*, 2 HUM. NATURE 419, 420 (1991) [hereinafter Daly & Wilson, *Reply to Gelles*] ("Sound explanations of lethal and sublethal assaults are certain to overlap considerably. . . .").

138. This is as many infants killed every two to six days as the number of children that died in the notorious Oklahoma City bombing of April 19, 1995. *See* Jo Thomas, *In Oklahoma City, Silence for Each of the Victims*, N.Y. TIMES, Apr. 20, 1996, at 7 (reporting ninteen children killed). For estimates, see, CURRENT TRENDS IN CHILD ABUSE REPORTING AND FATALITIES, *supra* note 113, at 12 (noting that approximately three children per day have died during the past ten years as a result of parental maltreatment); U.S. ADVISORY BD. ON CHILD ABUSE AND NEGLECT, OFFICE OF HUMAN DEV. SERVICES, U.S. DEP'T OF HEALTH AND HUMAN SERVICES, CHILD ABUSE AND NEGLECT: CRITICAL FIRST STEPS IN RESPONSE TO A NATIONAL EMERGENCY 56 (1990) [hereinafter CRITICAL FIRST STEPS] (estimating 1200 to 5000 child maltreatment fatalities per year (or 3 to 13 per day)). Confirmed child maltreatment fatalities have been rising in recent years, increasing 39% between 1985 and 1995. *See* CURRENT TRENDS IN CHILD ABUSE REPORTING AND FATALITIES, *supra* note 113, at 12. Children under the age of one comprise nearly half of all such fatalities. *See id.* at 20.

children—over auto accidents, accidental falls, choking on food, drowning, and the like.[139]

Exploring evolutionary perspectives on infanticide offers a glimpse into the sophistication of modern evolutionary understandings of behavior and lays an important foundation for demonstrating the final two stages of the model. In addition to improving our understanding of infanticide, the comprehensiveness of the theoretical structure will also shed useful light on child abuse generally.

The general theoretical foundation undergirding evolutionary theories on infanticide is well developed. Early animal behaviorists believed that animals rarely killed their own kind[140]—assuming that an appropriate inhibition *must* have evolved "for the good of the spe-

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Many believe the actual incidence of infanticide in fact far exceeds the conservative estimates. *See, e.g.*, CRITICAL FIRST STEPS, *supra*, at 2, 12 (estimating that 85% of all child abuse deaths are misidentified); U.S. DEP'T OF HEALTH AND HUMAN SERVS., A REPORT OF THE U.S. ADVISORY BD. ON CHILD ABUSE AND NEGLECT, A NATION'S SHAME: FATAL CHILD ABUSE AND NEGLECT IN THE UNITED STATES 23 (1995) [hereinafter A NATION'S SHAME]; Philip W. McClain et al., *Estimates of Fatal Child Abuse and Neglect, United States, 1979 Through 1988*, 91 PEDIATRICS 338, 338 (1993) (estimating that 85% of all child abuse deaths are misidentified); Starr et al., *supra* note 115, at 23, 32 (suggesting that many infanticides are misclassified as accidental deaths or SIDS (Sudden Infant Death Syndrome)); *cf.* John L. Emery et al., *Three Crib Deaths, A Babyminder and Probable Infanticide*, 28 MED. SCI. L. 205, 209-10 (1988) (concerning difficulty differentiating SIDS from murder by asphyxiation); Raymond Hernandez, *Mother Gets 75 Years for Smothering 5 of Her Children*, N.Y. TIMES, Sept. 12, 1995, at B5 (reporting case of a mother's confession to the murders of her five children, whose deaths were originally attributed to SIDS); Marjie Lundstrom & Rochelle Sharpe, *Getting Away with Murder*, PUB. WELFARE, Summer 1991, at 18, 22-24 (reporting that in many counties dead children are simply not autopsied).

139. *See* A NATION'S SHAME, *supra* note 138, at 20-21. In reaction, a number of states have undertaken specific legal initiatives to ensure that child fatalities are monitored and investigated. *See* SARAH R. KAPLAN, CHILD FATALITY LEGISLATION IN THE UNITED STATES app. at B3-B24 (1991) (summarizing child fatality legislation). Child fatality review teams are to ascertain the causes and incidence of preventable child deaths and to make recommendations for decreasing them. *See generally* TAMMY L. ANDERSON & SUSAN WELLS, DATA COLLECTION FOR CHILD FATALITIES: EXISTING EFFORTS AND PROPOSED GUIDELINES (1991) (surveying existing state efforts and proposing uniform data-collection procedures). For an example of reporting pursuant to statute, see ARIZONA DEP'T OF HEALTH SERVS., ARIZONA CHILD FATALITY REVIEW TEAM, NOVEMBER 1994.

140. *See* SARAH BLAFFER HRDY, THE LANGURS OF ABU: FEMALE AND MALE STRATEGIES OF REPRODUCTION 246 (1977) [hereinafter HRDY, THE LANGURS OF ABU]; Sarah Blaffer Hrdy & Glenn Hausfater, *Comparative and Evolutionary Perspectives on Infanticide: Introduction and Overview* [hereinafter Hrdy & Hausfater, *Comparative and Evolutionary Perspectives on Infanticide*], *Preface to* INFANTICIDE, *supra* note 79, at xiii-xiv; Stefano Parmigiani et al., *Infanticide and Protection of Young in House Mice (Mus domesticus): Female and Male Strategies* [hereinafter Parmigiani et al., *Infanticide and Protection of Young in House Mice*], *in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 341, 341.

cies."[141] It followed from this assumption that observed infant deaths must be either pathological,[142] accidental, or the result of unusual circumstantial stressors (such as extreme crowding) that would make infanticide good for the group as a whole.[143] When this later proved naive as a theoretical matter,[144] and inconsistent with facts as an evidentiary one,[145] primatologist Sarah Hrdy argued that infanticide could often be understood—not as evidence of pathology—but rather as the direct or indirect result of evolved, generally *adaptive* behavior.[146] Her analysis reflects this basic premise: Behavior that on average increases the reproductive success of an actor relative to the reproductive success of its contemporaries will persist and prolifer-

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141. *See, e.g.*, KONRAD LORENZ, ON AGGRESSION 109-38 (Marjorie Kerr Wilson trans., 1966) (arguing that intra-species aggression has been controlled, through evolutionary processes, for the good of the species). Under "normal" conditions, it was supposed, animals would "act to maintain, not disrupt, the prevailing social structure." HRDY, THE LANGURS OF ABU, *supra* note 140, at 246 (discussing early theories on infanticide).

142. *See, e.g.*, John A. King, *Maternal Behavior in Peromyscus*, *in* MATERNAL BEHAVIOR IN MAMMALS 58, 85-86 (Harriet L. Rheingold ed., 1963); *see also* Sarah Blaffer Hrdy, *Infanticide Among Animals: A Review, Classification, and Examination of the Implications for the Reproductive Strategies of Females*, 1 ETHOLOGY & SOCIOBIOLOGY 13, 20 (1979) [hereinafter Hrdy, *Infanticide Among Animals*] (discussing early theories on infanticide).

143. *See, e.g.*, John B. Calhoun, *Population Density and Social Pathology*, SCI. AM., Feb. 1962, at 139, 139; *see also* Ronald J. Brooks, *Causes and Consequences of Infanticide in Populations of Rodents*, *in* INFANTICIDE, *supra* note 79, at 331, 331-33 (discussing early theories on infanticide). This assumption has a long pedigree, dating back at least to W. HALL CALVERT, THE FURTHER EVOLUTION OF MAN: A STUDY FROM OBSERVED PHENOMENA 31-42 (1913), who attempted to use infanticide as proof against Darwinian evolution. Even today, the assumption continues to resurface. *See, e.g.*, SANDER J. BREINER, SLAUGHTER OF THE INNOCENTS: CHILD ABUSE THROUGH THE AGES AND TODAY 8 (1990) ("It is adaptive behavior, contributing to the survival of the species."); *see also* HOWARD BLOOM, THE LUCIFER PRINCIPLE: A SCIENTIFIC EXPEDITION INTO THE FORCES OF HISTORY 52-53 (1995) (assuming that maternal infanticide is inconsistent with the theory of kin selection).

144. In 1966, acclaimed biologist George Williams eviscerated "naive group-selectionism" (which presupposed that behavior evolved for the good of the group, rather than for the good of the individual)—thereby similarly gutting the theoretical foundations for then-prevailing theories on infanticide. *See* WILLIAMS, ADAPTATION AND NATURAL SELECTION, *supra* note 61.

145. *See* Hrdy & Haufster, *Comparative and Evolutionary Perspectives on Infanticide*, *supra* note 140, at xiv.

146. *See* Hrdy, *Infanticide Among Animals*, *supra* note 142; Sarah Blaffer Hrdy, *Male-Male Competition and Infanticide Among the Langurs (Presbytis Entellus) of Abu, Rajasthan*, 22 FOLIA PRIMATOLOGICA 19, 45-50 (1974) [hereinafter Hrdy, *Male-Male Competition*]. In this effort, Hrdy was building upon early speculation by Sugiyama that the behavior might be adaptive for individual males. *See* Y. Sugiyama, *Social Organization of Hanuman Langurs*, *in* SOCIAL COMMUNICATION AMONG PRIMATES 221 (Stuart A. Altmann ed., 1967).

ate, to the extent that the behavior is genetically influenced, and therefore heritable. Although her analysis may at first seem counter-intuitive (because at least when a parent kills its own offspring that would appear to reduce the killer's potential reproductive success) Hrdy's reasoning is now widely accepted by evolutionary biologists as compelling.[147]

Hrdy argued that because so many different behaviors can increase reproductive success, on average, generally adaptive behavior could contribute to the incidence of infanticide in four different ways. I will here term these theories:

- *The Exploitation Theory*;
- *The Resource Competition Theory*;
- *The Discriminative Parental Solicitude (DPS) Theory*; and
- *The Reproductive Access Theory*.[148]

The next few pages explore these in detail, focusing primarily on the last two, which, owing to the social organization of the human animal, will prove the most important to a subsequent analysis of human infanticide.

The Exploitation Theory highlights how an individual may on average increase reproductive success by exploiting an infant as either a food resource or as a tool for achieving a goal. A fox, for example, might obtain nourishment, and thus contribute to her own reproductive success, by eating the young of an unrelated member of her own species just as easily as by eating a like-sized member of an unrelated species.[149] *The Resource Competition Theory* highlights how an individual may on average increase its reproductive success by removing a vulnerable competitor for finite and scarce resources, such as by killing the offspring of a physically close "neighbor" in a crowded area.[150]

147. *See generally* INFANTICIDE & PARENTAL CARE, *supra* note 64 (consisting of a collection of articles discussing how infanticide can be an adaptive phenomenon).

148. *See generally* Hrdy, *Infanticide Among Animals*, *supra* note 142 (discussing four theories which offer various explanations for infanticide). Although I have kept the categories themselves intact, I have provided different names than Hrdy did in the original. This is a matter of semantics only, not an attempt to improve on Hrdy's original taxonomy. It is intended simply to avoid confusion among non-biologists. Hrdy also discusses social pathology in *id.* at 20.

149. *See id.* at 14-15. Cannibalism, contrary to popular misconception, is a common phenomenon in natural populations of many species including, for example, predatory fish. *See id.* at 14; Hrdy & Haufster, *Comparative and Evolutionary Perspectives on Infanticide*, *supra* note 140, at xv-xviii.

150. *See* Hrdy, *Infanticide Among Animals*, *supra* note 142, at 15-16.

The Discriminative Parental Solicitude (DPS) Theory[151] explains ultimate causes of infanticide as follows. Because natural selection favors behavior furthering reproductive success, parents prefer to treat offspring differently than genetic strangers (and differently than the offspring of strangers). In biological terms, parents are solicitous of offspring because their shared genes give them powerfully overlapping interests. Yet because parent and offspring are never genetically identical (in sexually reproducing species), those overlapping interests inevitably diverge: Every offspring is effectively a consumer of a parent's limited time and energy resources and natural selection is an ever-present economizing force that favors individuals whose investments are allocated in ways tending to optimize inclusive fitness. The precise allocation of a parent's investment among related and unrelated infants is therefore acutely sensitive to the "opportunity cost" of that investment. Natural selection effectively punishes the genetic complements of parents that allocate parental investment in one way whenever similarly situated competitors earn *greater* fitness returns by allocating the same amount of parental investment in *another* way—to different existing or future offspring, for example. Thus, natural selection will favor the ability to deliver parental investment to the offspring most capable of turning that investment into reproductive success.[152]

This theory therefore predicts that the motivational mechanisms influencing parental behavior will have evolved in such a way that parents will, on average, act as if they value a particular infant in direct proportion to that infant's probable contribution to parental inclusive fitness.[153] Such *infant-specific variation in parental investment* (whether conscious or unconscious) is thus the essence of discriminative parental solicitude: Parents discriminate among potential recipients of their solicitousness.[154] DPS theory therefore suggests that parents will generally allocate their resources among

151. *See supra* note 83 and accompanying text.

152. That is, just as natural selection will have favored parents who provide more to kin than to non-kin, it will also have favored parents that provide more to some juveniles genetically related to them than to others equally genetically related. For more on the subject of this paragraph, see DALY & WILSON, HOMICIDE, *supra* note 98, at 42; Martin Daly & Margo Wilson, *Evolutionary Social Psychology and Family Homicide*, 242 SCI. 519, 521-22 (1988) [hereinafter Daly & Wilson, *Evolutionary Social Psychology*] (concerning confirmations of DPS predictions in many empirical studies); Trivers, *Parental Investment and Sexual Selection*, *supra* note 63, at 139.

153. *See* Daly & Wilson, *Child Maltreatment*, *supra* note 46, at 101.

154. *See* DALY & WILSON, HOMICIDE, *supra* note 98, at 42.

infants according to their assessment of the following factors:[155]

- the probable degree of relatedness between parent and infant;
- observable attributes of the offspring (such as health, size, or deformity) that correlate with its eventual ability to translate parental investment into subsequent reproductive success; and
- alternative loci of parental investment (such as healthier existing offspring or offspring potentially reared in the future, when better resources may be available).[156]

Consequently, *The DPS Theory* suggests that there are at least two different avenues by which generally adaptive, evolved behavioral predispositions may contribute to an adult's causing the death of an infant.

The first avenue concerns infants unrelated to the parent. An infant that must rely on the resources of an unrelated adult is somewhat more likely to die of neglect or to be killed by that adult, simply because, on average, the infant will not evoke the same solicitousness as would an offspring. Since *not* caring for infants is the default (or initial) evolved predisposition (in the absence of relatedness cues), the adult will on average be less tolerant, less willing to provide, and less protective than would the infant's own parent.

The second avenue concerns infants related to the parent. An offspring's risk of neglect or infanticide will increase as the opportunity cost of future parental investment in it increases. Natural selection favors genetically influenced predispositions tending to reduce parental investment in a particular offspring toward zero when the benefits of redirecting finite parental investment toward an offspring's existing or future siblings are likely to be greater than the benefits of continued support of the offspring in question. An adult therefore may increase its reproductive success, on average, by eliminating one of its own offspring when the minimum parental

155. *See id.* at 42-43 (building on the work of RICHARD ALEXANDER, DARWINISM AND HUMAN AFFAIRS 109 (1979); Trivers, *Parental Investment and Sexual Selection*, *supra* note 63; Trivers, *Parent-Offspring Conflict*, *supra* note 63, and arguing that parental behavior observable today should have evolved toward distributing parental investment among offspring and others in proportions that optimize parental fitness); Margo Wilson & Martin Daly, *The Psychology of Parenting in Evolutionary Perspective and the Case of Human Filicide* [hereinafter *The Psychology of Parenting in Evolutionary Perspective*], *in* INFANTICIDE AND PARENTAL CARE, *supra* note 64, at 73, 76 (same).

156. *See* ALEXANDER, DARWINISM AND HUMAN AFFAIRS, *supra* note 3, at 109; DALY & WILSON, HOMICIDE, *supra* note 98, at 42; Hrdy & Hausfter, *Comparative and Evolutionary Perspectives on Infanticide*, *supra* note 140, at xxx.

investment that that offspring requires would probably yield higher fitness returns for the parent if it were directed instead to another existing or future offspring.[157] In other words, natural selection will favor males and females that, put crudely, are disposed to "trade in" one offspring for another one better situated to contribute to their own reproductive success—as, for example, when the killed offspring was ill-timed, of poor quality, or supernumerary.[158]

Because natural selection favors certain sex differences in behavior, particularly within internally fertilizing species,[159] *The DPS Theory* predicts that male and female parents often will assess their investment costs and payoffs differently, reflecting their different reproductive prospects for the future, and hence their different opportunity costs for any given quantum of parental investment. More specifically, because minimum necessary male investment for creating a new offspring (sperm) is less than minimum female investment (egg, womb, nutrition, and often nursing), and maximum reproductive success can be far higher for males than for females, the opportunity cost of continued investment in an existing offspring will tend to be higher for males than for females. Moreover, because males can reap the same fitness returns as females from smaller investments, males in such species may be more likely than females to terminate investment in any given infant.[160]

The fourth theory, *The Reproductive Access Theory,* highlights how an individual may on average increase reproductive success by killing an infant, *if* such an act frequently affords that individual increased access to the reproductive investment of a member of the opposite sex. This *Reproductive Access Theory,* which manifests intra-sexual conflict generated by sexual selection, suggests that the likelihood of infanticide may have nothing to do with the potential

157. *See* Martin Daly, *Parent-Offspring Conflict and Violence in Evolutionary Perspective, in* SOCIOBIOLOGY AND THE SOCIAL SCIENCES 25 (Robert W. Bell & Nancy J. Bell eds., 1989). For a discussion arguing that DPS better explains parent-offspring conflict than Freud's theories, see Martin Daly & Margo Wilson, *Is Parent-Offspring Conflict Sex-Linked? Freudian and Darwinian Models*, 58 J. PERSONALITY 163 (1990).

158. I recognize that such a bleak image may strike some people as shocking. The statement is intended to be descriptive and to imply no normative judgment whatsoever.

159. *See supra* text accompanying note 83.

160. Opportunity cost for both males and females decreases as an infant approaches reproductive maturity. *See* Martin Daly & Margo Wilson, *Abuse and Neglect of Children in Evolutionary Perspective* [hereinafter Daly & Wilson, *Abuse and Neglect of Children*], *in* NATURAL SELECTION AND SOCIAL BEHAVIOR 405, 406 (Richard D. Alexander & Donald W. Tinkle eds., 1981) ("[W]hen a large proportion of the requisite parental investment for the raising of an offspring has been expended and relatively little more is required, parents should tolerate greater risks before abandoning dependent young.").

reproductive success of the *infant* (as it did in *The DPS Theory*). Instead, it may correlate with the extent to which infanticide may increase the ability of a member of one sex, typically a male, to access the reproductive resources of a member of the other sex, typically a female.[161]

In many creatures, for example, including the primates, the very act of nursing one infant to weaning age impedes a female from further conception. This temporary contraceptive effect, known as *lactational amenorrhea*, appears to adaptively regulate the interval between successive offspring (known as the "inter-birth interval"), which otherwise may be so short as to be suboptimal for raising each infant to independence.[162] Cessation of nursing, for whatever reason, almost immediately restarts the female's capacity to conceive, which also accelerates her availability to males as a reproductive resource. Consequently, killing an unrelated, unweaned infant can be adaptive for an infanticidal male.[163]

The loss of a dependent infant brings the female back into estrus, shortens the inter-birth interval, and increases the chance that the infanticidal male can quickly commence his own gene replication

161. *See generally supra* notes 71-74 and accompanying text (discussing sexual selection). Males compete with other males not simply for access to a female, but for access to her when she is reproductive, and advantage in this competition is measured by an increase in male reproductive success.

162. *See* R.D. Martin, *Phylogenetic Aspects of Primate Reproduction: The Context of Advanced Maternal Care*, *in* MOTHERHOOD IN HUMAN AND NONHUMAN PRIMATES: BIOSOCIAL DETERMINANTS 16, 16-18, 23-25 (C.R. Pryce et al. eds., 1994) [hereinafter MOTHERHOOD]. The effect is operative in humans. *See* ELAINE MORGAN, THE DESCENT OF THE CHILD: HUMAN EVOLUTION FROM A NEW PERSPECTIVE 83 (1995); John E. Anderson et al., *Breast-Feeding, Birth Interval, and Infant Health*, 74 PEDIATRICS 695, 695 (1984); Thomas A. Cable & Lee A. Rothenberger, *Breast-Feeding Behavioral Patterns Among La Leche League Mothers: A Descriptive Survey*, 73 PEDIATRICS 830, 834 (1984) (describing prolonged lactational amenorrhea as "a common effect of unrestricted breast-feeding"); Renata Forste, *Effects of Lactation and Contraceptive Use on Birth-Spacing in Bolivia*, 42 SOC. BIOLOGY 108 (1995); Martin, *supra*, at 25; Audrey E. Rosner & Susan K. Schulman, *Birth Interval Among Breast-Feeding Women Not Using Contraceptives*, 86 PEDIATRICS 747, 750-51 (1990); Artemis P. Simopoulos & Gilman D. Grave, *Factors Associated with the Choice and Duration of Infant-Feeding Practice*, 74 PEDIATRICS 603, 612 (1984).

163. It may seem counter-intuitive that a female would willingly mate with a killer. But while natural selection will favor female counterstrategies to resist infant-killing, *see infra* notes 173, 193, 199, 218 and accompanying text, should that battle be lost the killing male becomes one of the *most* desirable mates; his demonstrated dominance of the infant's mother (and often father) increases the likelihood that offspring he sires will be similarly dominant—and better contribute to the female's reproductive success than the offspring of less dominant males. Recent video footage shows a lioness actually initiating copulation with the male that killed her cubs. *See Animal Cannibals* (Discovery Channel television broadcast, Nov. 5, 1996).

through her.[164] Over scores of generations, for example, a monkey who simply happened to carry a gene combination predisposing it to selectively infanticidal behavior would therefore leave, according to this theory, more descendants than would a monkey whose genes predisposed it to behave in ways that did not equally increase reproductive success.[165] Given time, the descendants of the infanticidal male would become sufficiently numerous that the behavior could be described as typical of individuals within the species.[166] In fact, once the killing of unrelated infants began, males that did *not* practice it would effectively be penalized by evolutionary forces.[167]

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164. *See* Hrdy, *Infanticide Among Animals*, *supra* note 142, at 17-18. In addition, when resources are scarce, selective infanticide also terminates the diversion of resources to young non-relatives, ultimately (albeit indirectly) increasing the resources available to the infanticidal male's offspring and his other relatives. *See id.* at 15. Non-offspring relatives may translate such marginally increased resources into greater reproductive success, thereby increasing the inclusive fitness of the selectively infanticidal male.

165. It can hardly be stressed enough that no rational calculus on the part of the male is implied or necessary. It is only necessary that there at some time have been an animal who responded to a commonly encountered environmental situation in a particular and genetically influenced fashion that happened to result in more copies of its genes appearing in successive generations than did genes of contemporaries predisposed to act differently. *See* HRDY, THE LANGURS OF ABU, *supra* note 140, at 278 (making this point forcefully).

166. The proportion of males that might actually carry the gene sequence at any given time has been mathematically modeled in M. Chapman & G. Hausfater, *The Reproductive Consequences of Infanticide in Langurs: A Mathematical Model*, 5 BEHAV. ECOLOGY & SOCIOBIOLOGY 227 (1979), and Glenn Hausfater, *Infanticide in Langurs: Strategies, Counterstrategies, and Parameter Values* [hereinafter Hausfater, *Infanticide in Langurs*], *in* INFANTICIDE, *supra* note 79, at 257.

167. *See* HRDY, THE LANGURS OF ABU, *supra* note 140, at 277; Hausfater, *Infanticide in Langurs*, *supra* note 166, at 281. If this seems unclear, the technique presented *supra* Part I.B.3 may help. Imagine a population of monkeys 1000 generations before the present. Let the individuals in this hypothetical population that are of reproductive age be considered Generation 1. Suppose that, due to naturally occurring mutations, three unrelated males among the offspring of Generation 1 contain novel gene combinations, each predisposing its bearer to respond to generalized environmental stimuli in a particular fashion. One combination makes its bearer more likely than other members of his species to provide for and protect any infant of his species, regardless of whether or not it is genetically related to him. A second combination makes its bearer more likely than others to kill all infants he comes across, even those he sired himself. A third combination makes its bearer more likely than others to selectively kill infants unrelated to him that are dependent upon females with whom he might mate.

In what proportions, relative to each other, might the gene combinations for these behaviors appear in Generation 1000? Only the third combination is likely to have spread widely throughout the populations in generations succeeding Generation 1. The first two combinations will on average divert more investment from activities contributing to their own replication than will combinations likely to be already present in the population at large. Even if each individual bearing one of these two combinations in Generation 1, and each of its male progeny who shares his father's combination, fathers only one less offspring during its reproductive life than is average for males in that popu-

In sum, infanticide modeled by the specific *Exploitation, Resource Competition, DPS,* and *Reproductive Access* theories derive from the mid-level evolutionary theories reflecting resource acquisition, kin selection, parental investment, and sexual selection, respectively. Unsurprisingly, these specific evolutionary theories are not truly alternative or mutually exclusive. There would be, for example, a dually adaptive significance to cannibalizing the offspring of potential competitors, reflecting both the *Exploitation* and *Resource Competition* theories.[168] Moreover, potential RS benefits of infanticide will accrue unequally in each of the four categories, depending upon the degree of relatedness and the sexes of both the killer and the killed.[169]

b. The Predictions of Evolutionary Theories: An Example

As stated earlier, this first step of *The Information Stage* explores not only the evolutionary theories, but also the predictions they generate that bear on the defined behavior. Taken together, the above theories logically generate many specific, testable predictions.[170] Among them, for example:

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lation, the proportion of individuals in successive generations who bears that combination will steadily decline. In contrast, the selectively infanticidal male will generally increase his reproductive success relative to that of the other two males. Moreover, he generally improves his reproductive success relative to that of the male who sired the killed infant, and will probably increase his reproductive success relative to the average reproductive success of the other males in the population. The genetic predisposition for selective, condition-dependent infanticide will be present in increasing proportions of future generations. This result will be resisted by any adaptive mechanisms that predispose mothers to, for example, protect their offspring from marauders. On such evolved counterstrategies, see *infra* notes 173, 193, 199, 218 and accompanying text.

168. *See, e.g.*, Laurel R. Fox, *Cannibalism in Natural Populations*, 6 ANN. REV. ECOLOGY & SYSTEMATICS 87 (1975); *see also* Carolyn M. Crockett & Ranka Sekulic, *Infanticide in Red Howler Monkeys (Alouatta seniculus), in* INFANTICIDE, *supra* note 79, at 173, 188 (explaining that any case of infanticide that yields reproductive advantage will also probably diminish competition for resources).

169. A slightly oversimplified model, assuming that the killer and killed either are or are not related, yields eight different possibilities: 1) male kills related male infant; 2) male kills related female infant; 3) female kills related male infant; 4) female kills related female infant; 5) male kills unrelated male infant; 6) male kills unrelated female infant; 7) female kills unrelated male infant; 8) female kills unrelated female infant.

170. Both these general predictions, and the predictions of the *DPS* and *Reproductive Access* theories, exist in a wide variety of forms in the literature. *See, e.g.*, D. Anthony Collins et al., *Infanticide in Two Populations of Savanna Baboons, in* INFANTICIDE, *supra* note 79, at 193, 211-12; Hrdy, *Infanticide Among Animals, supra* note 142, at 17; Christian Vogel & Hartmut Loch, *Reproductive Parameters, Adult-Male Replacements, and Infanticide Among Free-Ranging Langurs (Presbytis entellus) at Jodhpur (Rajasthan), India, in* INFANTICIDE, *supra* note 79, at 237, 253; Frederick S. vom Saal, *Proximate and Ultimate Causes of Infanticide and Parental Behavior in Male House Mice, in* INFANTICIDE, *supra* note 79, at 401, 401.

- *General Predictions*

1) it will not be uncommon for individuals to kill other members of their own species;
2) infanticide will not be confined to high-density populations or to animals living in otherwise stressed or disturbed habitats.

The *DPS* and *Reproductive Access* theories, which primarily apply, respectively, to species exhibiting parental care and to that subset of those species that (like humans) fertilize internally, generate even more specific predictions.

- *Predictions of DPS Theory*

Among species manifesting a reproductive strategy requiring significant parental investment, the following factors will be among those that increase the likelihood of infanticide:

1) youth of the infant (reflecting a higher cost of rearing to reproductive age, compared to an older offspring, as well as a lower probability of surviving to reproductive age);
2) signs of poor infant health, such as physical or mental defects (indicators of relatively low potential contribution to reproductive success);
3) youth of the mother (correlating with a relatively large percentage of the total reproductive years remaining); and
4) limited availability of parental resources, due to either resource scarcity, absence of a partner that may also invest in the infant, or both (which reduces the likelihood of the infant's survival).

- *Predictions of Reproductive Access Theory*

1) infanticide by adult males will be more commonly observed in those species in which females typically invest a great deal in each offspring than in those species in which they do not; and
2) infanticide by adult males will be more commonly observed among species in which, on average, the absence of a nursing

infant accelerates a mother's ability to conceive (the termination of lactational amenorrhea) than in those species in which such absence does not significantly affect that ability.

And in such species:

a) an infant will be far likelier to be killed by an unrelated male than by a related male;
b) an infant killed by an adult male will be far likelier to be un-weaned (still nursing) than weaned;
c) infanticidal males will more likely be those with only recent access to an infant's mother than those that might have sired the infant;
d) infanticidal males will, on average, impregnate the mother of a killed infant earlier than if her infant had not been killed;[171]
e) infanticidal males will become markedly less infanticidal one gestation period after gaining sexual access to a female;[172]
f) an infant born after an unrelated male gains physical access to its mother will be at greater risk of being killed if it is born in a period shorter than the gestation period; and
g) females will exhibit counterstrategies to prevent invading males from killing their infants.[173]

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171. Selectively infanticidal behavior can only be adaptive if the male's act does not decrease the likelihood that the female will mate with him. *See* Sarah Blaffer Hrdy et al., *Infanticide: Let's Not Throw Out the Baby with the Bath Water*, 3 EVOLUTIONARY ANTHROPOLOGY 151, 151 (1995).

172. After one gestation period, there is an increased risk that the male's own offspring will be present.

173. As to this last prediction, note that through selective infanticide the male is increasing his reproductive success at some expense to the female, who has already invested considerable resources in birthing and raising an infant that is related to her. Under some circumstances, such as where heritable traits contribute substantially to male status, a female might increase her reproductive success by mating with a male of higher status than the father of the child she is nursing. Among mountain gorillas, for example, the mother of an infant killed by a newly dominant male generally increases her social status within the group. *See* Dian Fossey, *Infanticide in Mountain Gorillas (Gorilla gorilla beringei) with Comparative Notes on Chimpanzees*, *in* INFANTICIDE, *supra* note 79, at 217, 218. Yet, depending on how the costs (including those for increased vigilance) of her continued investment in an existing offspring (considering the likelihood of successfully raising it to reproductive age) compare with the opportunity costs of that continued investment, the female may not always increase her reproductive success by acquiescing in a male's infanticide. This creates a situation in which natural selection would favor female behaviors that minimize the risk that an infant would be killed. Concerning such

In sum, this first step of *The Information Stage* paves the way to explore possible contributions of evolutionary analysis to pursuit of the legal goal by identifying relevant evolutionary theories and specifying the predictions they generate. Here, for example, *if* the propensity to commit infanticide is genetically influenced (and thus heritable), and *if* on average it operates to increase the actor's reproductive success, according to the logic of the *DPS* and *Reproductive Access* theories, we should expect to see that the predictions just enumerated will be largely accurate descriptions of actual observations.

2. What Empirical Evidence Bears on Those Predictions?

The second step of *The Information Stage* requires that the evolutionary theories' predictions be tested rigorously by the empirical evidence.[174] Ethical, practical, and legal limitations, of course, proscribe the scope and nature of human experimentation, and human cognitive capacities can make it difficult to assess the relative merits of alternative explanations of behavior. Consequently, the best initial indicators of the coherence of any evolutionary theory must come from preliminary surveys of experimental and observational evidence from elsewhere in the animal kingdom.[175] Theories that do not robustly survive this initial examination, with respect to non-primate animals, probably are not worth pursuing. In contrast, those that do

evolved female counterstrategies, such as aggressiveness toward new males and postconception estrous behavior, see HRDY, THE LANGURS OF ABU, *supra* note 140, at 242-90; Hausfater, *Infanticide in Langurs, supra* note 166, at 272-79; Hrdy, *Infanticide Among Animals, supra* note 142, at 30-35; Parmigiani et al., *Infanticide and Protection of Young in House Mice, supra* note 140, at 342-54; Anne E. Pusey & Craig Packer, *Infanticide in Lions: Consequences and Counterstrategies, in* INFANTICIDE AND PARENTAL CARE, *supra* note 64, at 277; Volker Sommer, *Infanticide Among the Langurs of Jodhpur: Testing the Sexual Selection Hypothesis with a Long-Term Record, in* INFANTICIDE AND PARENTAL CARE, *supra* note 64, at 155, 176; and Bruce Svare & Michael Boechler, *Protection and Abuse of Young in Mice: Influence of Mother-Young Interactions, in* INFANTICIDE AND PARENTAL CARE, *supra* note 64, at 465. Concerning evolved male counter-counterstrategies, see Parmigiani et al., *Infanticide and Protection of Young in House Mice, supra* note 140, at 354-58; Pusey & Packer, *supra*, at 277, 291-93.

174. A third step, *see infra* Part II.B.3, will then require that the results of this test be assessed. Consequently, the second and third steps of this stage constitute a mini-cycle that may be repeated several times with the data from various different species until a decision can comfortably be reached upon whether to: 1) continue with the subsequent evolutionary analysis; 2) further refine a theory developed in step one; or 3) abandon further analysis.

175. Although behavioral theories that require analytic reasoning are incapable of explaining the behavior of creatures without such reasoning ability, theories (like most evolutionary theories) that do not depend on analytic reasoning can potentially explain some behaviors of creatures, like humans, that do manifest such ability. That is, the existence of reason does not logically require that all behavior trace to reason.

survive make it advisable to survey evidence regarding primate relatives of humans and, subsequently, any available evidence about humans themselves.

To demonstrate this step in the model, therefore, this section sequentially surveys evidence on infanticide committed by non-primates, non-human primates, and human primates.[176] The evidence will be organized with reference to Hrdy's four-theory framework, with principal emphasis upon the predictions of the *DPS* and *Reproductive Access* theories. Because an exhaustive and mechanical study of facts corresponding to every prediction generated above is unnecessary to demonstrate evolutionary analysis in law, this section will provide only a general overview and representative sampling of evidence illustrative of the kind sufficiently detailed and relevant to further a useful evolutionary analysis. Readers willing to review this evidence will see the emergence of a deeply interwoven series of animal behaviors, almost shockingly consistent with the predictions of evolutionary theories, and will begin to see the promise of evolutionary analysis, which will be explored more fully in the third and fourth stages.

a. Infanticide in Non-Primates: The Evidence

In a great many non-primate species, contrary to popular assumption, adults very regularly kill infants of their own species.[177] Though the massive supporting literature is not without its interpretational issues, truly abundant empirical evidence reveals that, in many species, the great majority of infant killings occur independently of population density or disturbance and sort comfortably into one or more of the evolutionary theories Hrdy developed.[178]

176. The criteria by which other species are deemed similar to or different from humans, for this purpose, may vary significantly according to the behavior being studied. *See* Robert Foley, *Studying Human Evolution by Analogy, in* CAMBRIDGE ENCYCLOPEDIA OF HUMAN EVOLUTION, *supra* note 34, at 335. With respect to some aspects of mating institutions, for example, some bird species (such as those largely reflecting serial monogamy) will exhibit reproductive strategies more similar to human practices than some primate species (such as those with an overtly polygamous mating structure). Nevertheless, the sequence suggested in the text provides a serviceable default.

177. *See* Hrdy & Hausfater, *Comparative and Evolutionary Perspectives on Infanticide*, *supra* note 140, at xiv ("[I]nfanticide and cannibalism are for many animals everyday occurrences during those seasons when infants are present." (citation omitted)). In a great deal of other species, infanticide, though less common, nonetheless appears significantly to affect reproductive biology and social behavior. *See id.*

178. *See* studies collected in INFANTICIDE, *supra* note 79; INFANTICIDE & PARENTAL CARE, *supra* note 64. Although most studies of immediate relevance were conducted in the wild, it is important to note the valuable and overwhelmingly consistent contributions

Many species of protozoa, rotifers, flatworms, squid, crustaceans, arachnids, insects, amphibians, fishes, birds, rodents, and carnivorous mammals, for example, frequently dine on their own kind—evidence consistent with *The Exploitation Theory*.[179] In fact, in some of these species, more than 75% of all live young are consumed by same-species adults.[180] In addition, many species of birds, insects, and rodents commonly engage in infanticide best characterized as consistent with *The Resource Competition Theory*.[181] A nest's newly dominant female wasp, for example, often destroys eggs laid by subordinate females in available rearing cells and replaces them with her

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that laboratory studies provide regarding the controlled testing of very narrow hypotheses and insights into the proximate mechanisms of adaptive behavior. For examples of these, see Robert W. Elwood & Hazel F. Kennedy, *Selective Allocation of Parental and Infanticidal Responses in Rodents: A Review of Mechanisms, in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 397; David J. Gubernick, *Biparental Care and Male-Female Relations in Mammals, in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 427, 445-54; Parmigiani et al., *Infanticide and Protection of Young in House Mice*, *supra* note 140; Glenn Perrigo & Frederick S. vom Saal, *Behavioral Cycles and the Neural Timing of Infanticide and Parental Behavior in Male House Mice, in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 365; Svare & Boechler, *supra* note 173, at 465. In each case, evidence must be understood within the context of an often-elaborate reproductive strategy that is beyond the scope of this Article.

179. *See, e.g.*, Dominey & Blumer, *supra* note 79, at 43; Robert W. Elwood & Malcolm C. Ostermeyer, *Infanticide by Male and Female Mongolian Gerbils: Ontogeny, Causation, and Function, in* INFANTICIDE, *supra* note 79, at 367; U. William Huck, *Infanticide and the Evolution of Pregnancy Block in Rodents, in* INFANTICIDE, *supra* note 79, at 349, 354; Moshe Jakubowski & Joseph Terkel, *Infanticide and Caretaking in Non-Lactating Mus musculus: Influence of Genotype, Family Group and Sex*, 30 ANIMAL BEHAVIOUR 1029, 1032-33 (1982); Gary A. Polis, *Intraspecific Predation and "Infant Killing" Among Invertebrates, in* INFANTICIDE, *supra* note 79, at 87; Kenneth M. Rosenberg & Gordon F. Sherman, *The Role of Testosterone in the Organization, Maintenance and Activation of Pup-Killing Behavior in the Male Rat*, 6 HORMONES & BEHAV. 173 (1975); Thelma E. Rowell, *Maternal Behaviour in Non-Maternal Golden Hamsters (Mesocricetus auratus)*, 9 ANIMAL BEHAVIOUR 11 (1961); Paul W. Sherman, *Reproductive Competition and Infanticide in Belding's Ground Squirrels and Other Animals, in* NATURAL SELECTION & SOCIAL BEHAVIOR, *supra* note 160, at 311, 323-27; Martin P. Simon, *The Influence of Conspecifics on Egg and Larval Mortality in Amphibians, in* INFANTICIDE, *supra* note 79, at 65, 72-80; Yoram Yom-Tov, *The Effect of Food and Predation on Breeding Density and Success, Clutch Size and Laying Date of the Crow*, 43 J. ANIMAL ECOLOGY 479, 480 (1974).

180. *See* Polis, *supra* note 179, at 87, 92. The extremity of this cannibalism, incidentally, appears to be genetically inheritable. *See* Gary A. Polis, *The Evolution and Dynamics of Intraspecific Predation*, 12 ANN. REV. ECOLOGY & SYSTEMATICS 225, 230 (1981); Polis, *supra* note 179, at 87.

181. *See, e.g.*, Elwood & Ostermeyer, *supra* note 179, at 367; Douglas W. Mock, *Infanticide, Siblicide, and Avian Nestling Morality, in* INFANTICIDE, *supra* note 79, at 3; R. Mykytowycz & M.L. Dudzinski, *Aggressive and Protective Behaviour of Adult Rabbits Oryctolagus cuniculus Towards Juveniles*, 43 BEHAVIOUR 97 (1972); Polis, *supra* note 179, at 87, 96-98; Sherman, *supra* note 179, at 323-27; S. Turillazzi & R. Cervo, *Oophagy and Infanticide in Colonies of Social Wasps, in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 213 (surveying the literature on infanticide and cannibalism).

own,[182] and female seals and sea lions viciously attack unrelated young.[183] Moreover, both birds and amphibians often exhibit infanticide strongly suggestive of *The DPS Theory*. For example, parent birds acting to eliminate the one chick of two or more that has the poorest survival prospects[184] contribute to the statistic that, in some species, infanticide is the most important cause of nestling mortality.[185]

Infanticide characteristic of *The Reproductive Access Theory* (in which breeding opportunities rather than ecological resources are at issue), appears in a wide variety of species of insects,[186] arachnids,[187] and birds,[188] as well as in many mammals. This phenomenon tends to be most prevalent in mating systems in which a male has recently gained access to a female with an infant unlikely to be his own, and where the tenure of such access is on average fairly short.[189] In rodents such as house mice and prairie dogs, for example, intruding

182. *See* Turillazzi & Cervo, *supra* note 181, at 213 (and studies cited therein). Eggs destroyed in such a circumstance may represent as much as 50% of all eggs present in the nest. *See id.* at 220-23. Similar phenomena have been observed in other social insect colonies. *See id.* at 213. Among social wasps, a newly dominant female will generally attempt to destroy the entire immature brood of a nest she has usurped, unless it is the nest of a sister. *See id.* at 224. A subordinate female whose eggs have not all been destroyed will kill male sons of the dominant female while leaving her own sons intact. *See id.* at 232. Although there is some historical evidence, principally from the first half of this century, that some dominant females occasionally ate their own eggs along with those of other females, most recent studies are consistent with the predicted outcomes. *See id.* at 214, 231-32.

183. *See* LeBeouf & Campagna, *supra* note 84, at 263-73. Indeed, female seals and sea lions often vie for opportunities to inflict fatal bites on an unrelated pup, particularly one attempting to nurse. *See id.* at 264.

184. *See* Forbes & Mock, *supra* note 64, at 237-38 (surveying the literature). In birds, both parents and siblings regularly kill chicks. *See* Mock, *supra* note 181, at 7. Moreover, parents will often eat the victim, apparently reclaiming some of the parental investment. *See* Forbes & Mock, *supra* note 64, at 237-39. Siblicide, in which parents generally acquiesce, also generally appears to serve parental interests in optimizing brood size. *See id.* at 250. Furthermore, the likelihood of infanticide is inversely correlated with the availability of resources. *See id.* at 237-38; Mock, *supra* note 181, at 3 (birds); Simon, *supra* note 179, at 65, 84-85 (amphibians).

185. *See, e.g.*, MOLLER, *supra* note 71, at 201 (finding that infanticide accounts for approximately 32% of all nestling mortality in barn swallows); Mock, *supra* note 181, at 7.

186. *See* Polis, *supra* note 179, at 87, 95.

187. *See, e.g.*, Jutta M. Schneider & Yael Lubin, *Infanticidal Male Eresid Spiders*, 381 NATURE 655 (1996).

188. *See* MOLLER, *supra* note 71, at 110, 199-203.

189. *See* Chapman & Hausfater, *supra* note 166; Sarah Blaffer Hrdy, *Infanticide as a Primate Reproductive Strategy*, 65 AM. SCIENTIST 40, 45 (1977) [hereinafter Hrdy, *Infanticide as a Primate Reproductive Strategy*]. In those rare species, such as the button quail, where females compete for parental investment by males, females aggressively destroy eggs laid by other females. *See* Hrdy, *Infanticide Among Animals*, *supra* note 142, at 18.

males generally kill all unrelated young at any opportunity.[190] Significantly, the infanticidal behavior of males in these species generally correlates closely with the female reproductive cycle, diminishing *precisely* one gestation period after the male's ejaculation—and reemerging after a period precisely equivalent to that of the female's birth-to-weaning interval (during which period the male's own offspring might be present).[191] Furthermore, in some rodent species infanticidal males kill as many as 40% of all infants.[192] Females, in turn, exhibit narrowly tailored counterstrategies, responding with increased hostility to those males most likely to commit infanticide.[193]

The patterns of infanticide among lions are among the most studied and most striking among the non-primate species. For although a female will normally not conceive again until her cubs reach twenty months of age, she will become receptive to a dominant male in the pride within mere days if those cubs die, typically conceiving in about four months. This sixteen-month maximum acceleration creates opportunities in which, by killing small, unrelated cubs, an intruding male could sire his own cubs eight months earlier, on average, than if he spared them.[194] And actual observations of certain prides over twenty-four consecutive years[195] reveal that newly domi-

190. The pattern is particularly obvious among rodent species. *See generally* Elwood & Ostermeyer, *supra* note 179, at 374 (finding that 63% of males housed with nonpregnant females attempted to cannibalize a pup, while less than 33% did so when housed with pregnant females); Huck, *supra* note 179, at 349, 354 (citing Huck et al., *Infanticide in Male Laboratory Mice: Effects of Social Status, Prior Sexual Experience, and Basis for Discrimination Between Related and Unrelated Young*, 30 ANIMAL BEHAVIOUR 1158 (1982) (finding one-half of males killed unrelated pups, while only one-fifteenth of males killed their own pups)). *See generally* Parmigiani et al., *Infanticide and Protection of Young in House Mice*, *supra* note 140 (surveying general literature on animal infanticide and, more specifically, mice).

191. *See, e.g.*, Perrigo & vom Saal, *supra* note 178, at 365-66; vom Saal, *supra* note 170, at 401.

192. *See* John L. Hoogland, *Nepotism and Infanticide Among Prairie Dogs*, *in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 321, 323 (surveying the literature). Immigrant females are responsible for some of this because they regularly kill unrelated infants. *See id.* at 322.

193. *See* Parmigiani et al., *Infanticide and Protection of Young in House Mice*, *supra* note 140, at 341-45; Sommer, *supra* note 173, at 176-78; Svare & Boechler, *supra* note 173, at 465.

194. *See* Pusey & Packer, *supra* note 173, at 281.

195. *See generally* B.C.R. Bertram, *Social Factors Influencing Reproduction in Wild Lions*, 177 J. ZOOLOGY 463 (1975) (summarizing seven-year study of reproductive patterns of two lion prides); Craig Packer & Anne E. Pusey, *Infanticide in Carnivores*, *in* INFANTICIDE, *supra* note 79, at 31 (surveying the evidence then starting to accumulate concerning infanticide among carnivores); Pusey & Packer, *supra* note 173, at 277 (surveying literature on infanticide in lions).

nant males almost *inevitably* cause the death of every small cub present at the time of their takeover, except during takeovers of prides whose members are closely related to them.[196] Indeed, infanticide by male lions accounts for nearly 25% of all deaths of nursing cubs (with the risk to a cub of being killed declining rapidly with age).[197] And while the composition of males in a pride turns over periodically, DNA analyses tellingly reveal that at any given time all surviving cubs born in a pride are sired by the resident males.[198] In lions, too, females exhibit narrowly tailored counterstrategies.[199]

b. Infanticide in Non-Human Primates: The Evidence

Infanticide among non-human primates was first observed in the wild in 1965.[200] Today, primatologists consider it a "widespread"[201] behavior, having been observed in every major primate group, including the prosimians, the New and Old World monkeys, and the apes.[202] Some infant primates die in circumstances consistent with the *Exploitation Theory*. Both male and female chimpanzees, for example, have been known to kill and eat infants, and macaque infants sometimes are fatally used as "buffers" during antagonistic episodes between adults.[203] Other infants are killed in circumstances implicating *Resource Competition*, such as when a female chimpanzee kills the infant of another female in the same group.[204] To date there has

196. *See* Pusey & Packer, *supra* note 173, at 277, 279-80 (reporting that unrelated adult males and subadults are generally evicted).

197. *See id.*

198. *See* D.A. Gilbert et al., *Analytical DNA Fingerprinting in Lions: Parentage, Genetic Diversity, and Kinship*, 82 J. HEREDITY 378, 382-83 (1991).

199. *See* Pusey & Packer, *supra* note 173, at 277, 282-91 (noting, for example, that females with cubs distinguish roars of resident and non-resident males, responding with flight or hostility to latter).

200. *See* Yukimaru Sugiyama, *On the Social Change of Hanuman Langurs (Presbytis entellus) in Their Natural Conditions*, 6 PRIMATES 381, 412-16 (1965). Although Sugiyama noted that infanticide caused females to resume sexual receptivity, *see id.* at 415-17, the relevance of this to male reproductive strategies was undeveloped until Sarah Blaffer Hrdy's publication of *Male-Male Competition*, *supra* note 146.

201. HRDY, THE LANGURS OF ABU, *supra* note 140, at 287-88.

202. *See Id.* at 242-90; JEAN BALCH WILLIAMS, INFANTICIDE IN NONHUMAN PRIMATES: A BIBLIOGRAPHY (1991) (including 245 sources); Hrdy, *Infanticide as a Primate Reproductive Strategy*, *supra* note 189, at 46 ("[W]e are discovering that the gentle souls we claim as our near relatives in the animal world are by and large an extraordinarily murderous lot.").

203. *See* Mariko Hiraiwa-Hasegawa & Toshikazu Hasegawa, *Infanticide in Nonhuman Primates: Sexual Selection and Local Resource Competition*, *in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 137, 144; Hrdy, *Infanticide Among Animals*, *supra* note 142, at 14.

204. *See* Hiraiwa-Hasegawa & Hasegawa, *supra* note 203, at 149; Hrdy, *Infanticide*

been little observation of primate infanticide that would implicate the *DPS Theory* and no other.[205] However, patterns of infanticide observed thus far under both natural and laboratory conditions in five of the six non-human primate branches are in fact powerfully consistent with specific predictions of the *Reproductive Access* explanation of infant-killing,[206] as one might expect of species that exhibit large maternal investment and lactational amenorrhea.

Among the widely accepted conclusions:

- Infanticide among primates:
  1) is committed almost exclusively by adult males unrelated to the infant;
  2) almost exclusively targets unweaned infants;
  3) is almost exclusively committed by newly dominant adult males;
  4) prompts the mother of a killed infant to resume sexual receptivity within days or weeks (significantly more quickly than if the infant survived);
  5) usually results in the killing male siring the next offspring of the female whose infant he killed;
  6) is not confined to high-density populations or to animals living in disturbed habitat; and
  7) can be provoked predictably (in the experimental context) by removing a group's dominant male.[207]

In one population of more than 1000 langur monkeys, for example, studied at a single field site between 1969 and 1987,[208] males invading a breeding group *regularly* attacked and killed infants sired by other males[209]—ultimately killing nearly 30% of all infants born

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Among Animals, supra note 142, at 15.

205. The extent to which, in some circumstances, the *DPS* and *Reproductive Access* theories can each explain the same phenomena is explored *infra* Part II.B.4.

206. *See* Hiraiwa-Hasegawa & Hasegawa, *supra* note 203, at 137 (surveying the literature on the redtail monkey, the blue monkey, Campbell's monkey, the purple-faced langur, the silvered leaf-monkey, the black colobus, the white colobus, the mountain gorilla, the mantled howler, the red howler, and japanese monkeys); *see also* Hrdy et al., *supra* note 171, at 151 (excepting tarsiers); Lysa Leland et al., *Infanticide by Adult Males in Three Primates Species of Kibale Forest, Uganda: A Test of Hypotheses, in* INFANTICIDE, *supra* note 79, at 151, 158-60 (addressing male redtail monkeys, blue monkeys, and red colobus monkeys); Sommer, *supra* note 173, at 173-74 (addressing langurs).

207. *See* HRDY, THE LANGURS OF ABU, *supra* note 140, at 242-90; Crockett & Sekulic, *supra* note 168, at 173; Hiraiwa-Hasegawa & Hasegawa, *supra* note 203, at 137, 139-42; Hrdy et al., *supra* note 171, at 152; Leland et al., *supra* note 206, at 151; Sommer, *supra* note 173, at 173-74; Vogel & Loch, *supra* note 170, at 237, 253-54.

208. *See* Hrdy et al., *supra* note 171, at 151.

209. *See* HRDY, THE LANGURS OF ABU, *supra* note 140, at 242-90; Hrdy, *Infanticide as*

within that troop.[210] At least 95% of the time, infanticidal males killed *unrelated* infants,[211] and at least 75% of the time the infanticidal male succeeded in siring subsequent offspring *with the victim's mother*, following a significantly shortened inter-birth interval.[212]

Incidents of infanticide are also "surprisingly common"[213] among gorillas and chimpanzees. In mountain gorillas, for example, fully 14% of all infants are killed by males.[214] And, in chimpanzees, while both males and females kill infants,[215] males generally target only those infants likely to be unrelated to them, that is, with females in or from another group.[216]

Moreover, and also as predicted by *The Reproductive Access* theory, evolved counterstrategies appear to be at work. Adult primate males generally tend more closely to the infants they have sired when other males are present,[217] and females exhibit a variety of behaviors that appear to be narrowly tailored counterstrategies to infanticidal attacks by males. For example, researchers have frequently observed:

1) females from different social ranks forming temporary coalitions to protect infants in the presence of strange males;
2) females with unweaned infants holding back in encounters with strange males or avoiding the boundaries of ranges altogether;
3) mothers attempting to abandon their infants in the company of familiar ousted males rather than take infants with them back to a troop with an interloper in it;
4) mothers avoiding and even attacking such interlopers;

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a Primate Reproductive Strategy, *supra* note 189, at 41-42; Sommer, *supra* note 173, at 155.

210. *See* Hrdy et al., *supra* note 171, at 153 (citing Sommer, *supra* note 173).

211. *See* Sommer, *supra* note 173, at 173-74.

212. *See id.*

213. Fossey, *supra* note 173, at 217, 234.

214. *See* David P. Watts, *Infanticide in Mountain Gorillas: New Cases and a Reconsideration of the Evidence*, 81 ETHOLOGY 1, 4-7 (1989).

215. *See* Fossey, *supra* note 173, at 217, 230-34; Hiraiwa-Hasegawa & Hasegawa, *supra* note 203, at 137, 144.

216. *See* Hiraiwa-Hasegawa & Hasegawa, *supra* note 203, at 144-50. Females who do kill generally kill infants of unrelated females. *See id.* However, the data from chimpanzees are not completely unequivocal, in part because a pronounced desire for meat is a complicating factor. *See id.* at 137, 139. Additionally, infanticide has not to date been observed among bonobos, close relatives of chimpanzees. Personal Communication with Dr. Frans de Waal, Yerkes Regional Primate Research Center and Psychology Department, Emory University, in Squaw Valley, Cal. (June 21, 1996).

217. *See* C.P. van Schaik & R.I.M. Dunbar, *The Evolution of Monogamy in Large Primates: A New Hypothesis and Some Crucial Tests*, 115 BEHAVIOUR 30, 45-48 (1990).

5) laissez-faire mothers transforming into obsessively restrictive ones in the presence of strange males; and
6) females migrating into groups coinciding with the lowest vulnerability to infanticide.[218]

c. Infanticide in Humans: The Evidence

When the data from non-human animals are not consistent with the predictions of evolutionary theories, one need not ordinarily assess whether data from the human animal are consistent. Aspects of the theories may be unsound. However, when the data from a wide variety of creatures appear largely consistent with the theories, as is the case here, and when the data from close relatives to humans also appear consistent, as is the case here, then an evolutionary analysis must turn dispassionate scrutiny to the patterns observable in human populations. If similar patterns emerge, then the theories might usefully contribute to both our understanding of the behavior, and to law's attempts to regulate it.

What follows illustrates the kind of research and the kind of evidence necessary to test evolutionary theories with empirical observations of the human animal. Specifically, it surveys cross-cultural and cross-time evidence of how *Homo sapiens sapiens* treat their offspring in order to continue assessing whether detailed knowledge of evolutionary theories can increase the effectiveness of our efforts to curtail various aspects of child abuse. If human psychology has been shaped by natural selection, for example, then we may expect to find in the ethnographic record a correspondence between the circumstances in which evolutionary theories predict diminished parental solicitude and the circumstances and rationales of actual infanticide.[219]

As will be seen below, ancient and modern humans not only kill infants with regularity, but they do so in circumstances powerfully

218. *See* Hrdy et al., *supra* note 171, at 151-52 (citing, *inter alia*, van Schaik & Dunbar, *supra* note 217). The first of these points is courtesy of a personal communication from Dr. Michael McGuire, who has extensive experience with vervet monkeys. For more on extra-familial female alliances and their several functions, see Dorothy L. Cheney, *Extra-familial Alliances Among Vervet Monkeys*, *in* PRIMATE SOCIAL RELATIONSHIPS: AN INTEGRATED APPROACH 278 (Robert A. Hinde ed., 1983). For further observations on evolved counterstrategies, see JANE GOODALL, THE CHIMPANZEES OF GOMBE: PATTERNS OF BEHAVIOR (1986); HRDY, THE LANGURS OF ABU, *supra* note 140, at 279-84 and Jan R. de Ruiter, *Infanticide Counter-Strategies*, 5 EVOLUTIONARY ANTHROPOLOGY 5 (1996).

219. *See* Wilson & Daly, *The Psychology of Parenting in Evolutionary Perspective*, *supra* note 155.

consistent with the predictions of evolutionary theory, and with the empirical evidence from other species. Because the truth of this counter-intuitive proposition is evident only when both the coherence of the larger picture and the detail of its constituent elements come into view, we will proceed from the general to the specific—looking first at the larger descriptive context and then examining the extent to which human child-killing distributes among the four theories Hrdy identified. We will subsequently explore several specific predictions, and, for brevity's sake, focus on only one of them (which addresses patterns in stepparent-stepchild relations) for illustrative purposes.

(1) Child-Killing in Homo sapiens sapiens*: An Overview*

Many today assume that human infanticide has always been both rare and universally condemned.[220] That is fantastically untrue. *Homo sapiens sapiens*, like other primates, has long been a *highly* infanticidal species.[221] Many historic and current societies have con-

220. *See, e.g.*, Roger Wertheimer, *Philosophy on Humanity, in* ABORTION: NEW DIRECTION FOR POLICY STUDIES 117, 135-36 n.15 (Manier et al. eds., 1977) (assuming that prohibitions against child-killing are "endorsed by a mono-lithic consensus"); *see also* Kathryn L. Moseley, *The History of Infanticide in Western Society*, 1 ISSUES L. & MED. 345, 345 (1986) (noting that "[w]e preferred to think that we had been exempted from the stigma of murdering our young"); Richard C. Trexler, *Infanticide in Florence: New Sources and First Results*, 1 HIST. CHILDHOOD Q. 98, 98-99 (1973) (reporting evidence to rebut assumption that infanticide is rare).

221. On the history of infanticide in humans, see BREINER, *supra* note 143 (examining infanticide in five ancient civilizations: Greece, Rome, Egypt, Israel, and China); WILLIAM BURKE RYAN, INFANTICIDE: ITS LAW, PREVALENCE, PREVENTION, AND HISTORY (1862); Mildred Dickemann, *Demographic Consequences of Infanticide in Man*, 6 ANN. REV. ECOLOGY & SYSTEMATICS 107 (1975) (containing an excellent review of the history of infanticide research and theory to 1975); Langer, *supra* note 137; Anna Ferraris Oliverio, *Infanticide in Western Cultures: A Historical Overview*, *in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 105; Susan C.M. Scrimshaw, *Infanticide in Human Populations: Societal and Individual Concerns*, *in* INFANTICIDE, *supra* note 79, at 439; Mason P. Thomas, Jr., *Child Abuse and Neglect: Part I: Historical Overview, Legal Matrix, and Social Perspectives*, 50 N.C. L. REV. 293 (1972); N. Prabha Unnithan, *Children as Victims of Homicide: Part I—Historical and Anthropological Research*, 23 CRIM. JUST. ABST. 146 (1991) [hereinafter Unnithan, *Historical and Anthropological Research*]; N. Prabha Unnithan, *Children as Victims of Homicide: Part II—Research on Child Homicide in Contemporary Societies*, 23 CRIM. JUST. ABST. 315 (1991); Frederick S. vom Saal, *The Role of Social, Religious and Medical Practices in the Neglect, Abuse, Abandonment and Killing of Infants*, *in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 43; Williamson, *supra* note 137.

The methods of eliminating an unwanted child, in humans, appear to have changed little over time. They run the gamut of human devices from deliberate killing, abandonment, and excessive neglect to placing children in particularly dangerous situations. One mother, for example, placed her baby in the feeding trough of hungry pigs. *See* Rene Leboutte, *Offense Against Family Order: Infanticide in Belgium from the Fifteenth*

doned, or at least tolerated, the killing of human offspring.[222] Although today reproduction can be carefully planned, surplus infants, that significantly drain already-taxed child-rearing resources, have often historically been looked upon as the unavoidable and inconvenient result of sexual desire.[223] The local moral intuition that

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Through the Early Twentieth Centuries, 2 J. HIST. SEXUALITY 159, 174 (1991). Drownings appear to be especially preferred (although that appearance may follow only from an increased likelihood of discovery). Between 1788 and 1829 in England, for example, babies were drowned in pits full of water, cisterns, wells, ponds, and even pans of water. *See* Samuel X. Radbill, *Children in a World of Violence: A History of Child Abuse*, *in* THE BATTERED CHILD 3, 6 (Ray E. Helfer & C. Henry Kempe eds., 4th ed. 1981) [hereinafter THE BATTERED CHILD]. Privies and sewers were then, and in earlier centuries, also especially favored, for obvious reasons. *See* MARIA W. PIERS, INFANTICIDE 14-15 (1978); DAVID L. RANSEL, MOTHERS OF MISERY: CHILD ABANDONMENT IN RUSSIA 6 (1988); Leboutte, *supra*, at 173; Radbill, *supra*, at 3, 6. For example, workers rebuilding Rennes in France in 1721 discovered the skeletons of more than 80 infants in the sewer. *See* Leboutte, *supra*, at 173.

Smothering a child, or beating it to death, were common methods that can still be observed today. *See, e.g.*, R. FIRTH, WE, THE TIKOPIA 415 (1957); N. HOWELL, THE POPULATION OF THE DOBE AREA !KUNG 119 (1979); CYRIL JOHN POLSON ET AL., THE ESSENTIALS OF FORENSIC MEDICINE 514-31 (1985); Radbill, *supra*, at 8-9; Scrimshaw, *supra*, at 439; Williamson, *supra* note 137, at 61, 64. The burial of living babies is also a common method, particularly throughout the Amazon. *See* CHARLES WAGLEY, WELCOME OF TEARS: THE TAPIRAPÉ INDIANS OF CENTRAL BRAZIL 137 (1977); Hrdy, *Fitness Tradeoffs*, *supra* note 82, at 33 (citing THOMAS GREGOR, ANXIOUS PLEASURES: THE SEXUAL LIVES OF AMAZONIAN PEOPLE 89 (1985)).

222. Scholars on the prevalence and incidence of infanticide generally lament the "remarkable gulf between the historical facts about the practice of infanticide, and what most people in present-day Western society take those facts to be." MICHAEL TOOLEY, ABORTION AND INFANTICIDE 316 (1983); *see also* 1, 2 THOMAS ROBERT MALTHUS, AN ESSAY ON THE PRINCIPLE OF POPULATION (4th ed. 1996) (reporting, in 1807, infanticide in Australia, the Pacific, North and South America, Central Asia, India, and China); TOOLEY, *supra*, at 322 ("[T]he moral intuitions of people in most societies regarding infanticide have differed significantly from those which are common in present-day Western society."); Martin Daly & Margo Wilson, *A Sociobiological Analysis of Human Infanticide* [hereinafter Daly & Wilson, *Sociobiological Analysis of Human Infanticide*], *in* INFANTICIDE, *supra* note 79, at 487, 488-95 (describing the prevalence of infanticidal practices); Langer, *supra* note 137, at 354 (noting infanticide freely discussed and condoned by authorities). According to one commentator:

> Infanticide is a practice present-day westerners regard as a cruel and inhuman custom, resorted to by only a few desperate and primitive people living in harsh environments. We tend to think of it as an exceptional practice.... The truth is quite different. Infanticide has been practised on every continent and by people on every level of cultural complexity.... Rather than being an exception, then, it has been the rule.

Williamson, *supra* note 137, at 61.

223. *See* Langer, *supra* note 137, at 354.

> For those without property, security or prospects, children were sometimes an unmitigated nuisance. There was the cost of feeding and housing them and the opportunity cost in the removal of the wife for a time from productive labour in order to breast-feed and look after the children. Even if the child could be gainfully employed after the age of seven, ... there were still seven years in which it

infanticide is cruel and inhuman is in fact a quite recent and minority view.[224]

An oft-cited statistic estimates that humans practiced infanticide at least as early as the Pleistocene (the Great Ice Age, roughly 70,000 to 10,000 years ago) when an estimated 15% to 50% of all children were killed.[225] Although little data are available to reveal specific patterns in infanticidal practices, we do know that infanticide was not uncommon among ancestral hunter-gatherer, horticulturalist, and stratified agrarian societies,[226] and that the killing of human children long remained prevalent among ancient Arabs, Chinese, Indians, and certain Hindu castes.[227] Greeks and Romans practiced infanticide widely, and often openly, by abandoning live infants in wild areas, a practice known as "exposure."[228] Furthermore, each Roman father of 700 B.C. possessed the legal right to sell, abandon, sacrifice, devour, or kill his child, particularly if he suspected it was not his own.[229] While the state generally disapproved of the widespread practice of exposing *healthy* infants—exposing weak and deformed infants was another matter entirely. The law of Sparta, for example, actually *required* the exposure of such babes,[230] and The Roman Law of the Twelve Tables specifically forbade the rearing of the deformed,[231] the death of whom Aristotle (and many believe Plato also) expressly ad-

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would have to be fed.

LAWRENCE STONE, THE FAMILY, SEX AND MARRIAGE IN ENGLAND 1500-1800, at 295 (abridged ed. 1979).

224. As one infanticide researcher put it, "[m]odern humanitarian sentiment makes it difficult to recapture the relatively detached attitude of [some] parents towards [some] offspring." Langer, *supra* note 137, at 354.

225. *See* Joseph B. Birdsell, *Some Predictions for the Pleistocene Based on Equilibrium Systems Among Recent Hunter-Gatherers, in* MAN THE HUNTER 229, 239 (Richard B. Lee & Irven DeVore eds., 1966).

226. *See* Dickemann, *supra* note 221, at 109.

227. *See* TOOLEY, *supra* note 222, at 315-16; *see also* Oliverio, *supra* note 221, at 107 (noting that in the ancient Middle East, Moabites, Phoenicians, and Jews practiced child sacrifice); Radbill, *supra* note 222, at 9 (reporting that in China, India, Mexico, and Peru, children were cast into rivers as offerings). Ritual sacrifice was also apparently common among ancient Hebrews, Egyptians, and Babylonians, as well as Mayans and Aztecs. *See* RYAN, *supra* note 221, at 177-258; Williamson, *supra* note 137, at 71-72.

228. *See* TOOLEY, *supra* note 222, at 316; Langer, *supra* note 137, at 354; Cynthia Patterson, *"Not Worth the Rearing": The Causes of Infant Exposure in Ancient Greece*, 115 TRANSACTIONS AM. PHILOLOGICAL ASS'N. 103, 104-23 (1985); Williamson, *supra* note 137, at 69.

229. *See* Radbill, *supra* note 221, at 6, 14; *see also* Max Radin, *The Exposure of Infants in Roman Law and Practice*, 20 CLASSICAL J. 337, 338-43 (1925) (discussing lawfulness of infanticide by fathers under Roman law).

230. *See* TOOLEY, *supra* note 222, at 316.

231. *See* BREINER, *supra* note 143, at 7 (citing Emiel Eyben, *Family Planning in Greaco-Roman Antiquity*, 11/12 ANCIENT SOC. 5 (1980-81)).

vocated.[232]

With the spread of the Christian religions, attitudes toward child-killing became less uniformly tolerant. Nevertheless, it was not until the fourth century A.D. that the Roman Emperors even made infanticide a crime[233]—and the practice continued regardless. In the early Middle Ages, for example, people generally maintained a convenient moral distinction between infanticide, which was prohibited, and mere exposure, which was not.[234] Either way, parents killed infants or left them to die "on a gigantic scale with absolute impunity, noticed by writers with the most frigid indifference."[235]

Few governments attempted to curb widespread infanticide until the mid-1700s.[236] In London, for example, "the daily sight of infant corpses thrown on dust heaps"[237] had inspired public support for a limited admission public child-rearing facility, a "foundling" hospital, on the theory that parents would give unwanted children to the state, rather than kill them, if such an option were available. Problems surfaced immediately. In English foundling hospitals, for example, as in similar ones throughout Europe and Russia, unwanted infants were nursed by "wetnurses" (paid lactating women), many of whom simply killed one of their own sucklings to take on a paying one in its stead.[238] In addition, new mothers could often be seen "scrambling and fighting"[239] to be first at a hospital's door, since hospital admissions were limited. Moreover, it was widely believed that many other parents of that time would still rather dispose of their children secretly than abandon them to the hospitals in full view of their contemporaries.

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232. *See* ARISTOTLE, POLITICS, book 7, ch. 16; PLATO, REPUBLIC 174, 410 (Waterfield trans., 1993); Patterson, *supra* note 228, at 113.

233. *See* Langer, *supra* note 137, at 355. Christian religions were influenced by Judaic law forbidding murder, and the eminent Jewish-Hellenistic philosopher Philo Judaeus denounced the exposure of children as a form of murder. *See id.*

234. *See id.*

235. 2 WILLIAM E.H. LECKY, A HISTORY OF EUROPEAN MORALS FROM AUGUSTUS TO CHARLEMAGNE 27 (1869); *accord* RANSEL, *supra* note 221, at 4; STONE, *supra* note 223, at 296-97; R.J. Kellett, *Infanticide and Child Destruction—The Historical, Legal and Pathological Aspects*, 53 FORENSIC SCI. INT'L 1 (1992) (providing historical overview of infanticide).

236. *See* Langer, *supra* note 137, at 356; Kellett, *supra* note 235, at 2-3; Trexler, *supra* note 220, at 99; Williamson, *supra* note 137, at 69. Scattered previous efforts to stem infanticide with church-sponsored foundling hospitals, mainly in Italy, had proved ineffectual. *See* Langer, *supra* note 137, at 356.

237. Langer, *supra* note 137, at 358.

238. *See* PIERS, *supra* note 221, at 52; RANSEL, *supra* note 221, at 207-08.

239. Langer, *supra* note 137, at 359 (citing JOHN BROWNLOW, THE HISTORY AND DESIGN OF THE FOUNDLING HOSPITAL 7 (1868)).

This led governments in many countries to experiment with open, unlimited admissions policies, which provide some suggestive glimpse into the rates (properly qualified) at which people acted to rid themselves, one way or another, of unwanted infants in the absence of—and even through—such policies.[240] In 1756, for example, the English Parliament threw the foundling hospital doors open to everyone, everywhere, throughout the kingdom.[241] Many European and Russian hospitals went further, instituting a double-blind "turning cradle" admissions technique, which preserved the anonymity of a parent who might, it was supposed, otherwise have killed the child.[242]

Response to these policies was staggering. In England, for example, three to four thousand babies were deposited every year, "collected in baskets from all over the country by itinerant baby transporters, who dumped the contents [at the foundling hospital] dead, dying or half-alive."[243] In the year 1833 alone, over *164,000* babies were left among roughly *300* foundling hospitals in France.[244] And, in the late 1800s, the central homes for foundlings in Moscow and St. Petersburg were taking in 17,000 and 9,000 infants per year, respectively, many having been collected by the *cartload*, for a parent-paid fee, by traveling entrepreneurs.[245]

Parents knew that most abandoned children would die. Babes were deposited in such great numbers, and with such notoriously small hope of survival, that the practice was often referred to simply as "legalized infanticide."[246] Indeed, so many babies deposited in England died (10,000 of the first 15,000, for example) that the foundling hospitals were called "little more than licensed death camps,"[247] a virtual "charnel-house for the dead."[248] The mortality rates were

240. *See* Langer, *supra* note 137, at 358-60. On the connection between abandonment and infanticide, see Hrdy, *Fitness Tradeoffs*, *supra* note 82.

241. *See* Langer, *supra* note 137, at 359.

242. Parents could deposit a baby on a specially-built turntable in the side of a windowless wall, ring a bell to signal the baby's presence, and then hurriedly leave without being seen. *See* RANSEL, *supra* note 221, at 62-83. Turntabling appears to have started in France with an 1811 decree of Napoleon. *See* JUDITH LORBER, PARADOXES OF GENDER 149-53 (1994); Langer, *supra* note 137, at 358.

243. STONE, *supra* note 223, at 298.

244. *See* Langer, *supra* note 137, at 359.

245. *See* RANSEL, *supra* note 221, at 3, 150.

246. Langer, *supra* note 137, at 359.

247. STONE, *supra* note 223, at 299.

248. Langer, *supra* note 137, at 359 (citing BROWNLOW, *supra* note 239, at 7).

even worse elsewhere,[249] ultimately compelling governments to close the foundling hospitals as a disastrous, failed experiment in the reduction of child-killing.[250] By the 1860s, then, it was once again common to see dead infants in English parks, ditches, and garbage heaps.[251] One hundred fifty dead infants were found each year in streets and waterways of Middlesex county alone,[252] and in the five years between 1855 and 1860, nearly 300 killed infants were found in the waterways and alleys of London.[253]

Roughly contemporaneously, more enterprising parents enrolled their infants in so-called "burial clubs"—a life insurance vehicle in which, for a one pound investment, a parent could reap three to five pounds of profit when that child was buried; because multiple policies were available, some parents enrolled their children in ten or more such clubs and "reap[ed] a rich return at the proper time."[254] The incidence of baby-farming and baby-dumping (collecting a fee for raising a child but killing it instead) was so frequent that in 1872 Parliament passed the Infant Life Protection Act.[255] Nevertheless, forty newborns were found in the Thames River during the winter of 1895

249. Because nearly all children admitted to hospitals were under a year old (96.5%), the very trip to the hospital from rural areas was often fatal. *See* JOAN SHERWOOD, POVERTY IN EIGHTEENTH CENTURY SPAIN: THE WOMEN AND CHILDREN OF THE INCLUSA 129, 139 (1988). Sixty to ninety percent of those surviving the trip, in the mid to late 1800s, died anyway—in part because many governments sent infants to wet nurses by whom they were sold or killed. *See* BREINER, *supra* note 143, at 7; RANSEL, *supra* note 221, at 257-59; Radbill, *supra* note 221, at 3, 7 ("[Eighty percent] of the illegitimate children put out to nurse in London during the nineteenth century died. As a matter of fact, some nurses had a reputation as skilled baby killers."). Additionally, 92% of foundlings in France died before their eighth birthday. *See* Hrdy, *Fitness Tradeoffs*, *supra* note 82, at 26 (citing A. DUPOUX, SUR LES PAS DE MONSIEUR VINCENT: TROIS CENTS ANS D'HISTOIRE PARISIENNE DE L'ENFANCE ABANDONNEE, REVUE DE L'ASSISTANCE PUBLIQUE (1958)). In Spain, the mortality rate approached 87% at the end of the century. *See* SHERWOOD, *supra*, at 125. At one Spanish foundling hospital, for example, 58% of the infants died before leaving—and of those who survived and were sent to wet nurses, 88% died. *See id.* at 174. This represents an overall survival rate of barely five children for each 100 left alive with the hospital. *See id.*

250. *See* Langer, *supra* note 137, at 359.

251. *See* RYAN, *supra* note 221, at 45-176; *see also* RANSEL, *supra* note 221, at 6 (describing infanticide in Europe).

252. *See* PETER C. HOFFER & N.E.H. HULL, MURDERING MOTHERS: INFANTICIDE IN ENGLAND AND NEW ENGLAND 1558-1803, at 159 (1981).

253. *See id.* at 159-60; *see also* RYAN, *supra* note 221, at 49-50 (quoting local publication that 500 infants were killed between 1856 and 1861 and that 60 were taken from waterways alone).

254. Langer, *supra* note 137, at 360; *accord* LIONEL ROSE, THE MASSACRE OF THE INNOCENTS: INFANTICIDE IN BRITAIN 1800-1939, at 136-58 (1986); RYAN, *supra* note 221, at 21-22.

255. *See* Langer, *supra* note 137, at 359-62.

alone.[256]

Today, just a century later, infanticide remains more disturbingly common than is generally acknowledged. In a modern-day South American country, for example, many poor Catholics reportedly view contraception as a bigger sin than infanticide, and not infrequently kill their seventh or eighth infant.[257] Additionally, in some modern human societies, more than 40% of all infants are intentionally killed.[258] In others, infanticide rates have been estimated between 15% and 20%.[259] In the United States, infanticide is nowhere near as rare an event as the media coverage of the notorious Susan Smith case seemed to suggest;[260] conservative estimates indicate that roughly 1200 to 5000 infants die from child abuse each year.[261] In California alone, in fact, the frequency with which live newborns are left in dumpsters has lead one hospital to post signs at the dumpsters stating "Don't Throw Away a Life"—and showing a large red "X" over a picture of outstretched arms tossing a baby into a trash can.[262]

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256. *See* HOFFER & HULL, *supra* note 252, at 160. For particularly gruesome accounts of infanticides in England, see NORMAN LUCAS, THE CHILD KILLERS (1970).

257. *See* PIERS, *supra* note 221, at 15-16.

258. *See* Wulf Schiefenhövel, *Reproduction and Sex-Ratio Manipulation Through Preferential Female Infanticide Among the Eipo, in the Highlands of West New Guinea, in* THE SOCIOBIOLOGY OF SEXUAL AND REPRODUCTIVE STRATEGIES 170, fig. 10.7 (Anne E. Rasa et al. eds., 1989).

259. *See* James V. Neel, *Lessons from a "Primitive" People*, 170 SCI. 815, 816 (1970).

260. *See, e.g.*, *Death and Deceit*, TIME, Nov. 14, 1994, at 43 (cover caption, "How Could She Do It?"). Federal health officials, considering child homicide as a whole, report that nearly three-quarters of all child homicides in the industrialized world occur in the United States. *See* Judith Havemann, *For Children, An Epidemic of Homicide: U.S. Leads Rich Nations in Violence Against Youth*, WASH. POST, Feb. 7, 1997, at A1.

261. *See* CRITICAL FIRST STEPS, *supra* note 138, at 56. For the purposes of this Article, such deaths are considered infanticidal. *See supra* note 137.

262. *See* John Ritter, *Dead Infants: A Grim Statistic*, USA TODAY, Mar. 17, 1995, at 3A. The hospital offers to ensure that the baby gets adopted.

(2) Representative Predictions

Adult *Homo sapiens sapiens* do kill infants in patterns predicted by each of the four theories Hrdy identified.[263] Consistent with *The Exploitation Theory,* infants have been eaten as a resource in a variety of human societies, spanning time and cultures from Pleistocene man to the Aztecs and from the Australian aborigines to the Eskimos[264] (often on the theory that the blood and flesh of slain infants would bring good health).[265] Ancient Chinese, Indians, Mexicans, and Peruvians often threw babies into rivers to bring good harvests and good luck, and many cultures sacrificed children by infixing them in building foundations to ensure their stability.[266] And some modern mothers intentionally induce sometimes fatal illness in their children in order to arouse sympathy and attention.[267] Consistent with *The Resource Competition Theory*, history shows that the dominant often suppress the reproduction of those deemed inferior, indirectly (as through castration) or directly (as via gas chambers). Indeed the Nazis developed an unusually frank plan to eliminate up to 50,000 Russian children "to reduce the direct growth of enemy strength [and] to impair its biological strength in the distant future."[268] And if certain texts be accurate, one King Herod's fear of a supplanting messiah led him to order the death of all males under the age of two,[269] while one Pharaoh, fearing the Jews, reportedly did likewise.[270]

Studies indicate, however, that the vast majority of human child-killings sort into patterns predicted by the *DPS* and *Reproductive Access* theories. For example, when prominent evolutionary psychologists Martin Daly and Margo Wilson examined a database of

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263. *See* Mildred Dickemann, *Concepts and Classification in the Study of Human Infanticide: Sectional Introduction and Some Cautionary Notes* [hereinafter Dickemann, *Concepts and Classification*], *in* INFANTICIDE, *supra* note 79, at 427, 428.

264. *See id.* at 428-29; Dickemann, *supra* note 221, at 108.

265. *See* Thomas, *supra* note 221, at 296.

266. *See id.*

267. *See, e.g.*, Lundstrom & Sharpe, *supra* note 138, at 21 (reporting on mother who apparently attempted to procure sympathy by feeding child vomit-inducing medicine until he died). Not all such exploitation is fatal. Parents anxious to secure pecuniary or other benefits from aroused sympathy have intentionally gouged eyes, amputated or twisted arms and legs, and broken or deformed feet. *See* PIERS, *supra* note 221, at 15-16; *see also* Radbill, *supra* note 221, at 3 (noting instance in which mother continually injected her child with fecal bacteria because she enjoyed being part of the "glamor of the hospital" (citation omitted)).

268. *See* Dickemann, *Concepts and Classification*, *supra* note 264, at 429 (quoting a Wehrmacht memorandum of June 1944).

269. *See Matthew* 2:16.

270. *See Exodus* 1:16.

materials in the Human Relations Area Files (HRAF) for sixty societies,[271] they found that infanticide was practiced in at least thirty-nine of the sixty societies and that the rationales for infanticide had been noted for thirty-five of those thirty-nine.[272] Cumulating the rationales across the thirty-five, Daly and Wilson compiled a total of 112 explanations for infanticide, which they subsequently sorted. They found powerful support for the hypotheses we examine here: Infanticide was nowhere common in circumstances that did *not* make reproductive, evolutionary sense, and in fact most rationales did.

Consistent with *The DPS Theory*, for example, which predicts that infanticide will increase commensurate with factors indicating that the prospects for a given child to significantly contribute to parental reproductive success are low, deformed or very ill children were frequently killed or abandoned in twenty-one of the thirty-five societies.[273] Furthermore, in only one of these societies was such behavior disapproved[274] (perhaps in part because such children often burdened the larger community as well). Fully half the rationales represented variations on maternal overburdening. In fourteen societies, for example, the birth of twins was commonly thought to require the killing of one.[275] These particular findings are consistent with those of other researchers, who have concluded that various human societies have commonly accepted child-killing when: the de-

271. These sixty are commonly considered the "Probability Sample" from which maximally accurate estimates can be made about the prevalence of various practices among humans at large. *See* Daly & Wilson, *A Sociobiological Analysis of Human Infanticide*, *supra* note 222, at 489 (explaining Probability Sample and HRAF). The probability sample was devised by cultural anthropologists to be independent and representative of world cultures. The HRAF contains ethnographic source material published up to 1971.

272. *See id.* This does not mean that infanticide does not occur in the other societies. *See, e.g.*, W.T. Divale & M. Harris, *Population, Warfare and the Male Supremacist Complex*, 78 AM. ANTHROPOLOGY 521, 533-35 & app. (1976) (reporting that 36% of preindustrial cultures studied (40 of 112) practiced infanticide commonly, and at least 13% (14 of 112) did so occasionally).

273. *See* Daly & Wilson, *Sociobiological Analysis of Human Infanticide*, *supra* note 222, at 490-92; *see also* Dickemann, *supra* note 221, at 117-20 (discussing deformity as a predictor); Nancy Scheper-Hughes, *Culture, Scarcity, and Maternal Thinking: Maternal Detachment and Infant Survival in a Brazilian Shantytown*, 13 ETHOS 291, 304-06 (1985) (discussing same).

274. *See* Daly & Wilson, *Sociobiological Analysis of Human Infanticide*, *supra* note 222, at 492.

275. *See id.* In these societies, the child designated for death was either the second born, the weaker, or the female. *See id.* Twin infanticide appeared more common in societies in which mothers have a heavy workload or have a minimum amount of assistance in raising their offspring. *See* Gary Granzberg, *Twin Infanticide: A Cross-Cultural Test of a Materialistic Explanation*, 1 ETHOS 405, 406-08, 410-11 (1973).

sired maximum number of children have already been born,[276] the spacing between them is inadequate,[277] the child is not of the desired sex,[278] the mother is mentally or physically defective,[279] one parent has

276. *See* 1 E.A. WESTERMARCK, THE ORIGIN AND DEVELOPMENT OF THE MORAL IDEAS 396-405 (2d ed. 1912); Hrdy, *Fitness Tradeoffs*, *supra* note 82, at 3, 6; *see also* Scrimshaw, *supra* note 221, at 439 (noting that Japanese farmers referred to infanticide as "thinning out"). This is "extremely prevalent" in societies in which custom determines how many children a family should have, such as in Melanesia and Polynesia, and among the Australian Aborigines and certain African tribes. *See* TOOLEY, *supra* note 222, at 315. Among the formerly highly mobile Australian Aborigines, for example, it was considered infeasible for a woman to carry more than one infant child with her as the tribe wandered. *See* HERBERT APTEKAR, ANJEA: INFANTICIDE, ABORTION AND CONTRACEPTION IN SAVAGE SOCIETY 159-60 (1931).

277. *See* Birdsell, *supra* note 225, at 239; Neel, *supra* note 259, at 816; Scrimshaw, *supra* note 221, at 446, 459; *cf.* Helen L. Ball & Catherine M. Hill, *Reevaluating "Twin Infanticide,"* 37 CURRENT ANTHROPOLOGY 856, 861 (1996) ("Twins may . . . be subjected to infanticide for birth spacing and / or population control, but because of lack of data we cannot adequately test these predictions at present."). Birth spacing has been more important in human history than is commonly realized, because resource-poor mothers may lose every child if resources are spread among them, rather than concentrated. *See* Williamson, *supra* note 137, at 64-65. Studies indicate that in humans the second child of a closely spaced pair is more likely to die. *See, e.g.*, D. Wolfers & S.C.M. Scrimshaw, *Child Survival and Intervals Between Pregnancies in Guayaquil Ecuador*, 29 POPULATION STUD. 479 (1975). In some parts of the world, "killing a newborn is often explained as a caring act, done to save the life of an older sibling who is too young to be weaned but is already a member of the social group and cherished as such." Williamson, *supra* note 137, at 63. Multiple births exacerbate the resources problem and often lead to thinning through infanticide. *See* Bojosi Otlhogile, *Infanticide in Bechuanaland: A Footnote to Schapera*, 34 J. AFR. L. 159, 161 (1990); Scrimshaw, *supra* note 221, at 446; Williamson, *supra* note 137, at 65. In such cases, the strongest child is generally kept. *See* Scrimshaw, *supra* note 221, at 446; *see also* Catherine M. Hill & Helen L. Ball, *Abnormal Births and Other "Ill Omens:" The Adaptive Case for Infanticide*, 7 HUM. NATURE 381, 382 (1996) (stating that twins (one or both) are generally victims of infanticide because they are "poorer quality" infants).

278. *See* BREINER, *supra* note 143, at 8 (noting that girls are generally killed more frequently than boys); KANTI B. PAKRASI, FEMALE INFANTICIDE IN INDIA (1970); RANSEL, *supra* note 221, at 11, 130-49; R.K. SAXENA, SOCIAL REFORMS: INFANTICIDE AND SATI (1975) (describing difficulties of trying to combat the practice of sex-biased infanticide in India); Sharon K. Hom, *Female Infanticide in China: The Human Rights Specter and Thoughts Towards (An)Other Vision*, 23 COLUM. HUM. RTS. L. REV. 249 (1991-92); Sheila Ryan Johnson, *Deferred Infanticide: Excess Female Mortality During Childhood*, *in* INFANTICIDE, *supra* note 79, at 463; Langer, *supra* note 137, at 354 (noting that in ancient times, generally more girls than boys were disposed of); Scrimshaw, *supra* note 221, at 439 (discussing female infanticide in China and India); Williamson, *supra* note 137, at 61, 63, 67-69 (noting that in those societies in which males are strongly preferred, the society prefers infanticide to abortion); *see also* Eric L. Charnov, *The Evolutionary Ecology of Sex Allocation: A Primer*, *in* INFANTICIDE, *supra* note 79, at 125 (discussing advantages of biasing offspring sex ratio); Jones, *Reproductive Autonomy and Evolutionary Biology*, *supra* note 3, at 187, 202-07 (discussing the Trivers-Willard hypothesis on the parental fitness effects of offspring sex, which vary as a function of both inherently different reproductive prospects of each sex and the differential influence of environmental conditions on those prospects); Owen D. Jones, *Sex Selection: Regulating Technology*

died,[280] the infant exhibits physical or mental defects,[281] or the parents are poor.[282]

Consistent with both the *DPS* and *Reproductive Access* theories, Daly and Wilson's study also found that fully twenty of the rationales explaining infanticide, from fifteen societies, highlighted non-paternity as a justification.[283] In two societies, for example (the Tikopia of Oceania and the Yanomamo of South America), men acquiring wives who already have children reportedly can put those children to death.[284] Again, this finding is supported by many other studies, which have found that eliminating an illegitimate child is one of the leading explanations of infanticide.[285]

More specifically, a brief and focused comparison of empirical evidence with several of the falsifiable predictions of evolutionary theories set forth in Part II.B.1.b above (and re-phrased for uniquely human contexts) will provide a representative sample of the research regarding infant deaths in humans.[286] The first five of these predictions derive principally from *DPS Theory*, applicable to species exhibiting significant parental investment. The last two derive principally from *Reproductive Access Theory,* applicable to species, such

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Enabling the Predetermination of a Child's Gender, 6 HARV. J.L. & TECH. 1, 3-19 (1992) (describing sex preferences around the world).

279. *See* CHARLES WAGLEY, WELCOME OF TEARS: THE TAPIRAPÉ INDIANS OF CENTRAL BRAZIL 251 (1977) (noting that the Tapirapé Indians buried the children of epileptic women immediately after birth).

280. *See* Scrimshaw, *supra* note 221, at 445.

281. *See* TOOLEY, *supra* note 222, at 315; Langer, *supra* note 137, at 353-54 ("Among non-Christian peoples (with the exception of the Jews) infanticide has from time immemorial been the accepted procedure for disposing ... of deformed or sickly infants."); Moseley, *supra* note 220, at 345-51; Otlhogile, *supra* note 277, at 162; Scrimshaw, *supra* note 221, at 446; Williamson, *supra* note 137, at 61, 64; *see also* H. Rutherford Turnbull, *Incidence of Infanticide in America: Public and Professional Attitudes*, 1 ISSUES L. & MED. 363 (1986) (reporting continuing biases against the handicapped).

282. *See* HOFFER & HULL, *supra* note 252, at 115 ("For the poor female servant who could not afford to lose her job, much less feed another mouth, just as for the overburdened cottager family with perhaps one too many offspring already, infanticide might have seemed a matter of survival."); ROSE, *supra* note 254, at 15-21; Langer, *supra* note 137, at 353-54.

283. *See* Daly & Wilson, *Sociobiological Analysis of Human Infanticide, supra* note 222, at 489.

284. *See id.*

285. *See* ROSE, *supra* note 254, at 22-34; RYAN, *supra* note 221, at 36 (reporting that, in many countries in the mid-1800s, the mortality rate of illegitimate children was 60% to 70% higher than for legitimate children); TOOLEY, *supra* note 222, at 315; Otlhogile, *supra* note 277, at 161-62; Radbill, *supra* note 221, at 5, 15; Scrimshaw, *supra* note 221, at 448; Williamson, *supra* note 137, at 61, 64-66.

286. *See supra* text accompanying notes 170-73. The predictions build, in part, on the seminal work ALEXANDER, DARWINISM AND HUMAN AFFAIRS, *supra* note 3.

as humans, manifesting lactational ammenorhea.[287]

Prediction 1: *The probability of child homicide by parents will be maximal with infants and will rapidly decline with a child's age, in contrast to child homicide by nonparents.*

Rationale: An inclination to end investment in dependent offspring, if adaptive, would be expected to occur more frequently when the children are young, because such children had (at least during the environment of evolutionary adaptation) a far lower probability than older children of surviving to reproductive age.

Fact: There is a major decrease in parental homicides following the first year of a child's life.[288]

Prediction 2: *Children of poor health will be at greater risk of infanticide than children of good health.*

Rationale: Natural selection will have favored parents that allocate their parental investments in offspring in proportions reflecting the projected increase in parental reproductive success each may ultimately provide.[289]

Fact: They are.[290] Much evidence suggests that mothers vary solicitude as a function of health indicators (such as birthweight[291])

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287. *See supra* note 162 and accompanying text.

288. *See* HOFFER & HULL, *supra* note 252, at 124 (noting that 80% of the cases involved neonate victims); ROSE, *supra* note 254, at 8 (noting that between 1863 and 1887 in England and Wales 61% of all homicides were of children under age one); ALISON WALLACE, N.S.W. BUREAU OF CRIME STATISTICS AND RESEARCH, ATTORNEY GEN. DEP'T, HOMICIDE: THE SOCIAL REALITY 111 (1986) (reporting that 49% of all child victims are killed before their first birthday; 68% killed before fifth birthday); Martin Daly & Margo Wilson, *Child Abuse and Other Risks of Not Living with Both Parents*, 6 ETHOLOGY & SOCIOBIOLOGY 197, 197 (1985) [hereinafter Daly & Wilson, *Child Abuse and Other Risks*]; Daly & Wilson, *Sociobiological Analysis of Human Infanticide*, *supra* note 222, at 496 (noting 137 infant deaths to 49 one-year-old deaths); Michael J. Durfee et al., *Origins and Clinical Relevance of Child Death Review Teams*, 267 JAMA 3172, 3172-73 (1992) (noting that 50% are under the age of one); Wilson & Daly, *Psychology of Parenting in Evolutionary Perspective*, *supra* note 155, at 83-85; *cf.* Starr, *supra* note 115, at 41 (reporting that 79% of physical abuse reports in Arizona, and 85% in Louisiana, concern children younger than four).

289. *See* Daly & Wilson, *Sociobiological Analysis of Human Infanticide*, *supra* note 222, at 492.

290. *See, e.g.*, Dickemann, *supra* note 221, at 117-20; *see also* Scheper-Hughes, *supra* note 273, at 304-06 (concluding that, in one Brazilian shantytown, poor infant health often triggers selective and fatal neglect).

291. *See* Wilson & Daly, *The Psychology of Parenting in Evolutionary Perspective*, *supra* note 155, at 90-92.

and that a very high percentage of children killed or abandoned at birth were born with handicaps or other disabilities.[292]

Prediction 3: *Infanticidal mothers will be relatively young.*

Rationale: Parental willingness to invest in present offspring, other things being equal, should increase as the parent's own remaining reproductive years dwindle. An offspring will effectively increase in value as the parent's ability to replace it approaches zero.

Fact: The frequency distribution of children per maternal age at birth of child varies significantly from the relative risk of abuse.[293] The

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292. *See* Dickemann, *supra* note 221, at 117-20; Oliverio, *supra* note 221, at 114-15. For more on the relationship between abuse and poor health, see INFANTICIDE AND THE HANDICAPPED NEWBORN (Dennis J. Horan & Melinda Dalahoyde eds., 1982); AMERICAN HUMANE ASS'N, NATIONAL ANALYSIS OF OFFICIAL CHILD NEGLECT AND ABUSE REPORTING 15 fig.4 (1978); Harold P. Martin et al., *The Development of Abused Children*, 21 ADVANCES PEDIATRICS 25 (1974); Carol W. Morse et al., *A Three-Year Follow-Up Study of Abused and Neglected Children*, 120 AM. J. DISEASES CHILDREN 439, 445 (1970); and Alice Sandgrund et al., *Child Abuse and Mental Retardation: A Problem of Cause and Effect*, 79 AM. J. MENTAL DEFICIENCY 327, 327-29 (1974).

293. For example, in Belgium, historically, the large majority of those committing infanticide were "young servants of rural origin." Leboutte, *supra* note 221, at 164 (citing Regina Schulte, *Infanticide in Rural Bavaria in the Nineteenth Century*, *in* INTEREST AND EMOTION: ESSAYS ON THE STUDY OF FAMILY AND KINSHIP 77, 77 (Hans Medick & David Warren Sabean eds., 1984)). In England, typically, women who kill neonates are poor, young, and unmarried. *See* POLSON ET AL., *supra* note 221, at 514; Morris Brozovsky & Harvey Falit, *Neonaticide: Clinical and Psychodynamic Consideration*, 10 AM. ACAD. CHILD PSYCHIATRY J. 673, 677 (1971); *see also* HOFFER & HULL, *supra* note 252, at 95, 97 (noting that the typical offender in England and New England is a young, unmarried woman); PIERS, *supra* note 221, at 18 (noting that mothers who abandon their babies in the hospital after giving birth are "invariably very young, unmarried, and desperately poor"); Constance B. Backhouse, *Desperate Women and Compassionate Courts: Infanticide in Nineteenth-Century Canada*, 34 U. TORONTO L.J. 447, 457 (1984) (finding that most women charged were "very young"); Brozovsky & Falit, *supra*, at 673, 682 (stating that mothers are usually young); Paul E. Bugos, Jr. & Lorraine M. McCarthy, *Ayoreo Infanticide: A Case Study*, *in* INFANTICIDE, *supra* note 79, at 503, 514 (noting that "infanticide rates are highest in the youngest age category"); Richard J. Gelles, *Poverty and Violence Toward Children*, 35 AM. BEHAV. SCIENTIST 258, 264-71 (1992) [hereinafter Gelles, *Poverty and Violence*] (noting that poor, young, single mothers with young children are most likely to report that they use violent behaviors toward their children); Neil S. Kaye et al., *Families, Murder, and Insanity: A Psychiatric Review of Paternal Neonaticide*, 35 J. FORENSIC SCI. 133, 134 (1990) (finding 90% of maternal neonaticide by mothers under 25 years old); P.T. d'Orbán, *Women Who Kill Their Children*, 134 BRIT. J. PSYCHIATRY 560, 561 (1979) (reporting on study of infanticidal women, with a mean age of 22.4); Phillip J. Resnick, *Murder of the Newborn: A Psychiatric Review of Neonaticide*, 126 AM. J. PSYCHIATRY 1414, 1415 (1970) (noting that mothers in the neonaticide group were significantly younger than mothers in the filicide group); Ania Wilczynski, *Images of Women Who Kill Their Infants: The Mad and the Bad*, 2 WOMEN & CRIM. JUST. 71, 76 (1991) (noting that infanticidal women are typically young); Ian Wilkey et al., *Neonati-*

risk of abuse is at its highest for children born to young mothers and declines steadily with the increasing age of the mother at birth of the child. That is, the risk of abuse for any given child declines as the mother's age at birth varies from thirteen to thirty-six.[294]

Prediction 4: *Infanticidal mothers will be relatively poor.*

Rationale: The probable contribution of an offspring to parental reproductive success decreases as parental access to relevant resources decreases.

Fact: Poor mothers are over-represented in samples of infanticidal mothers.[295]

Prediction 5: *Infanticidal mothers will relatively often be unmarried.*

Rationale: Lack of paternal support diminishes a child's prospective contribution to maternal reproductive success, and an increased proportional share of offspring rearing costs interferes with a female's opportunities to acquire a new mate and to raise additional offspring.

Fact: Although approximately 88% of babies born in Canada during one study period were born to legally married mothers, only

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cide, Infanticide and Child Homicide, 22 MED. SCI. & L. 31, 34 (1982) (reporting that many cases involve young, single, poor females).

294. *See* Daly & Wilson, *Child Abuse and Other Risks, supra* note 288, at 204. In one study, for example, 16% of the infanticidal mothers were 17 years old or less, while only 3% of all mothers were 17 years old or less. *See* Martin Daly & Margo Wilson, *Children as Homicide Victims* [hereinafter Daly & Wilson, *Children as Homicide Victims*], *in* CHILD ABUSE AND NEGLECT: BIOSOCIAL DIMENSIONS 201, 207, 210 (Richard J. Gelles & Jane B. Lancaster eds., 1987); Daly & Wilson, *Sociobiological Analysis of Human Infanticide*, *supra* note 222, at 497. This suggests a tendency for women to value their children more highly as their own reproductive value declines. *See* Daly & Wilson, *Child Abuse and Other Risks*, *supra* note 288, at 204, 207-08; *see also* DALY & WILSON, HOMICIDE, *supra* note 98, at 62 (discussing the correlation between infanticide and maternal age); Bugos & McCarthy, *supra* note 293, at 514 (noting that maternal infanticide decreases as a function of maternal age); Martin Daly & Margo Wilson, *Child Abuse Risk and Household Composition in Hamilton*, 31 J. ONTARIO ASS'N CHILDREN'S AID SOC'YS 11, 12 (1986) [hereinafter Daly & Wilson, *Child Abuse Risk and Household Composition*] (noting that maternal age is a risk factor for child abuse); Daly & Wilson, *Evolutionary Social Psychology*, *supra* note 152, at 522 (noting that rates of infanticides by mothers decrease as maternal age increases).

295. *See* RANSEL, *supra* note 221, at 153-54, 160-61 (noting that by early 1900s, over 80% of abandoned children were from the peasant class); Backhouse, *supra* note 293, at 457 (noting that majority are "from the lower class"); Brozovsky & Falit, *supra* note 293, at 682 (noting that mothers are usually poor); Gelles, *Poverty and Violence, supra* note 293, at 265-66; Kaye et al., *supra* note 293, at 134; Wilczynski et al., *supra* note 293, at 76 (noting that infanticidal mothers are typically poor); Wilkey et al., *supra* note 293, at 34.

40% of the mothers committing infanticide during that period were legally married.[296]

Prediction 6: *Children will be at greater risk of infanticide in stepparent households than in natural parent households.*

Rationales: Natural selection will have favored the allocation of parental investment proportional to the probable degree of relatedness between parent and child.[297] Absent perceived relatedness, average adults will be less psychologically motivated to provide for an infant. This decrease in solicitude may be expected, on the margin, to be positively correlated with stepchild deaths. Moreover, if ancestral human mating systems reflect lactational amenorrhea, a selectively infanticidal male might shorten an inter-birth interval and earlier produce offspring with that infant's mother.

Fact: Children in the United States under two years old are about *100 times* more at risk of lethal abuse at the hands of stepparents than of genetic parents.[298]

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296. *See* Daly & Wilson, *Children as Homicide Victims*, *supra* note 294, at 208; *see also* Backhouse, *supra* note 293, at 457 (noting that the "overwhelming majority of infanticidal mothers are single"); Brozovsky & Falit, *supra* note 293, at 682 (noting that infanticidal mothers were usually unmarried); Gelles, *Poverty and Violence, supra* note 293, at 270 (stating that single mothers are more likely to be abusive to their children); Kaye et al., *supra* note 293, at 134 (noting that mothers were usually unmarried); Resnick, *supra* note 293, at 1415 (noting that 81% of neonaticidal females were single); Wilczynski, *supra* note 293, at 76 (noting that infanticidal mothers are typically single); Wilkey et al., *supra* note 293, at 34 (noting that infanticidal mothers are young and single). Lack of male support is a strong risk factor for infanticide of children born in certain Amazonian tribes, for example. *See* Bugos & McCarthy, *supra* note 293, at 518, 520; Kim Hill & Hillard Kaplan, *Tradeoffs in Male and Female Reproductive Strategies Among the Ache: Part 2*, *in* HUMAN REPRODUCTIVE BEHAVIOUR, *supra* note 104, at 291, 297-98.

297. *See* Daly, *supra* note 157, at 32-34 (addressing the concept of parental investment).

298. *See* DALY & WILSON, HOMICIDE, *supra* note 98, at 89; Daly & Wilson, *Evolutionary Social Psychology*, *supra* note 152, at 520. The 100-fold figure appears to be based on reinterpretation of 1976 fatal abuse figures, revising downward, from 5.7% to 1%, the estimated number of all children living with stepparents, in light of more current information. *See* DALY & WILSON, HOMICIDE, *supra* note 98, at 88-89. Prior analysis (using the earlier and larger estimate) had suggested a 40-fold increased risk of abuse. *See* Daly & Wilson, *Child Abuse and Other Risks*, *supra* note 288, at 202 fig.1, 205; Daly & Wilson, *Child Abuse Risk and Household Composition*, *supra* note 294, at 11-12. Subsequent studies have consistently found dramatically elevated risk for children living with substitute parents. *See* DALY & WILSON, HOMICIDE, *supra* note 98, at 85-93 (providing overview of study results); Martin Daly & Margo Wilson, *Some Differential Attributes of Lethal Assaults on Small Children by Stepfathers Versus Genetic Fathers*, 15 ETHOLOGY & SOCIOBIOLOGY 207, 210 (1994) [hereinafter Daly & Wilson, *Differential Attributes*] (finding risk 60 times greater). For more on the subject, see generally Daly & Wilson,

Prediction 7: An infant will be far likelier to be killed by a male stepparent than by a female stepparent.

Rationale: Males eliminating unweaned, unrelated offspring of females to whom they have sexual access can potentially increase their reproductive success by shortening the inter-birth interval.

Fact: Most infant abuse by substitute parents is clearly stepfather abuse. Stepfathers not only kill children at higher rates than genetic fathers, but they also kill them in different ways and for different reasons.[299] For example, stepfathers are about 120 times more likely to beat a child to death than is a homicidal genetic father.[300]

3. How Does the Evidence Fit the Predictions?

Thus far, during this second stage of model evolutionary analysis, *The Information Stage*, we have explored the evolutionary theories, identified the predictions they generate, and examined empirical evidence relevant to those predictions. Although here the evidence apparently aligns with predictions, determining how well it does so will often require a distinct assessment. No simple measure exists to quantify precisely the vitality of a behavioral theory. Animal behaviors are not usually as objectively measurable as mass, volume, or electric charge. Although neither the presence nor absence of any one factor will generally validate or eviscerate a theory, that fact does not foreclose legitimate and useful description of a fit between theory and evidence as, for example, "non-existent," "loose," "tight," or "very tight." A theory's specific and falsifiable

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Children as Homicide Victims, *supra* note 294, at 211-12 (noting that stepparents are overrepresented in the causes of child homicides); Daly & Wilson, *Discriminative Parental Solicitude*, *supra* note 83; Daly & Wilson, *Evolutionary Social Psychology*, *supra* note 152, at 520 (stating that children in stepparent families are more often injured than those in families without stepparents).

Adoptions are expected to yield different patterns because they require more self-selected, additional, and affirmative acts than does becoming a stepparent. *See* Margo Wilson & Martin Daly, *Risk of Maltreatment of Children Living with Stepparents* [hereinafter Wilson & Daly, *Risk of Maltreatment*], *in* CHILD ABUSE AND NEGLECT: BIOSOCIAL DIMENSIONS 215, 218-19 (Richard J. Gelles & Jane B. Lancaster eds., 1987); *see also* Daly & Wilson, *Child Abuse Risk and Household Composition*, *supra* note 294, at 13 (noting that unlike an adoptive parent, a stepparent usually enters a relationship because he is attracted to the new mate, not because he is interested in raising the mate's children).

299. *See* Daly & Wilson, *Differential Attributes*, *supra* note 298, at 216.

300. *See id.* at 211. Genetic fathers, in contrast, are far more likely than stepfathers to kill a child in sorrow than in anger, either out of perceived necessity or as part of what is today termed a "rescue" homicide/suicide. *See id.* at 208.

predictions will appear accurate or inaccurate some rough percentage of the time, even if we expect that percentage to vary somewhat with the study population and ever-changing circumstances. The cumulative effects of assessing independently minor predictions can ultimately lead to the conclusion that a theory, overall, is extremely robust.

Such a conclusion will depend, in part, on three variables: 1) the number of predictions matched by the data; 2) the narrowness of the predictions matched by the data; and 3) the breadth of relevant species[301] constituting the prediction-data matches. The greater the number of predictions supported, the narrower the predictions themselves, and the more relevant species in which data are consistent, the greater the likelihood that the theory has actual explanatory power.

From discussions above, for example, this is what we now know of the evolutionary analysis of infanticide. We know that the *DPS Theory* predicts that natural selection will have favored over time any genetic predisposition in animals to treat offspring in ways that best contribute to reproductive success, according to observable offspring cues that on average correlate to that offspring's potential contribution to parental reproductive success. We know the predictions are falsifiable, with extremely narrow predictions (by sex, age, relatedness, and the like) of specific circumstances that will be nonrandomly represented among infanticidal incidents. We also know that a great many animals, in a great many species in the kingdom (including the primates), behave in ways powerfully consistent with these predictions. And we furthermore know that the primate *Homo sapiens sapiens* also exhibits patterns apparently consistent with these predictions, and thus with the patterns observable in many other species. Indeed, one must certainly conclude that infanticide in most human societies is considered appropriate in precisely those circumstances "in which it happens to be reproductively adaptive for the parties involved."[302]

More specifically, the *DPS Theory* predicts that in species with a reproductive strategy that involves sexual reproduction, internal fertilization, a lengthy gestation period, small brood size, a relatively long period of principally maternal investment, and male-male com-

301. *See supra* note 176.

302. Daly & Wilson, *Sociobiological Analysis of Human Infanticide*, *supra* note 222, at 495. This conclusion is consistent with observed patterns of homicide, which tend to be quite sensitive to the relatedness between aggressors. *See generally* DALY & WILSON, HOMICIDE, *supra* note 98, at 52, 54-55; Martin Daly & Margo Wilson, *Homicide and Kinship*, 84 AM. ANTHROPOLOGIST 372, 372-74 (1982).

petition for females, young, single, resource-poor females will be more prevalent in a group of females who killed an offspring than will: 1) older, resource-poor females; 2) young, resource-rich females; or 3) older, resource-rich females. And in fact they are. It predicts that the risk to an offspring of being killed by its mother will be highest during its infancy and will drop dramatically with increasing age. In fact it does. It predicts that unrelated or substitute parents will be over-represented among child-killers. And they are. The theory predicts that, among killed infants, a disproportionate number will have been sick, or otherwise handicapped. And that is so. Moreover, the *Reproductive Access Theory* predicts that, if the same species exhibits lactational amenorrhea, unweaned infants are far likelier to be killed than weaned infants, and that unrelated males are far likelier than unrelated females to do the killing. In fact, this is almost exclusively the case. For, as seen above, the data are consistent among species with similar reproductive strategies as diverse as house-mice, lions, langurs, and humans. (Indeed, the adaptive significance of infanticide is so well accepted today that it appears in the major textbooks on evolutionary biology.[303])

Evaluating this sample from the theory and data on infanticide has illustrated this third step of *The Information Stage* in evolutionary analysis. It has also illustrated a very tight theory-data fit, since matched predictions are numerous, extremely specific, and powerfully supported by empirical data from a wide variety of human and

303. *See, e.g.*, ALCOCK, *supra* note 16, at 13-19, 169-72; KREBS & DAVIES, *supra* note 95, at 5-10; TRIVERS, *supra* note 43, at 71-77 (discussing infanticide among langurs). The once-popular view that all instances of infanticide represented pathological responses to social stresses has been almost universally abandoned. *See* HRDY, THE LANGURS OF ABU, *supra* note 140, at 246-47; INFANTICIDE & PARENTAL CARE, *supra* note 64, at xi-xiii; Hiraiwa-Hasegawa & Hasegawa, *supra* note 203, at 137-39; Sommer, *supra* note 173, at 155-57; *see also* Crockett & Sekulic, *supra* note 168, at 186-89; Glenn Hausfater, *Infanticide in Nonhuman Primates: An Introduction and Perspective*, *in* INFANTICIDE, *supra* note 79, at 145, 146-47; Leland et al., *supra* note 206, at 164; Vogel & Loch, *supra* note 170, at 253.

The transition was not without its early resistors, however, who for some time continued to champion the primacy of the social pathology hypothesis. *See, e.g.*, Jane E. Boggess, *Infant Killing and Male Reproductive Strategies in Langurs (Presbytis entellus)*, *in* INFANTICIDE, *supra* note 79, at 283, 286-88; Jane E. Boggess, *Troop Male Membership Change and Infant Killing in Langurs (Presbytis entellus)*, 32 FOLIA PRIMATOLOGICA 65, 100-03 (1979); Richard Curtin & Phyllis Dolhinow, *Primate Social Behavior in a Changing World*, 66 AM. SCIENTIST 468, 473-75 (1978). For replies to Boggess, arguing that the hypothesis should be rejected, see Sarah Blaffer Hrdy, *Assumptions and Evidence Regarding the Sexual Selection Hypothesis: A Reply to Boggess*, *in* INFANTICIDE, *supra* note 79, at 315; Yukimaru Sugiyama, *Proximate Factors of Infanticide Among Langurs at Dharwar: A Reply to Boggess*, *in* INFANTICIDE, *supra* note 79.

non-human species.[304]

4. Do the Theories Apply to Humans?

A prediction-evidence fit cannot alone establish that an ultimate explanation of behavior in other animals explains an evolutionary origin of similar behavior in humans. Given a tight fit, however, it is parsimonious and thus preferable to presume that it does.[305] Those who would argue that a given difference between humans and other animals makes a theory inapplicable bear the burden of persuasion (not *vice versa*).[306]

There are two important cautions. The first is that the presumption is rebuttable. Parsimony may *suggest* that particular human and non-human behaviors have the same origins, but cannot alone make it so. Parsimony provides only a default starting point, when theories appear equally robust, and one must always consider that unique elements of human evolution may have yielded strikingly similar behaviors with unrelated origins in both humans and non-humans.[307] The second caution is that there may often be more than one robust evolutionary theory that can, alone or simultaneously with others, play a role in explaining the behavior under study in various non-

304. A small number of principally non-biologist commentators have raised objections to this conclusion that are beyond the scope of a discussion of model evolutionary analysis. *See, e.g.*, Gelles & Harrop, *supra* note 126; Robert W. Sussman et al., *Infant Killing as an Evolutionary Strategy: Reality or Myth?*, 3 EVOLUTIONARY ANTHROPOLOGY 149 (1995) (arguing that infanticide data could be better interpreted as genetically inconsequential epiphenomena of aggressive episodes). To date, this is a distinctly minority view. Compare, for example, the sources just cited to Daly & Wilson, *Reply to Gelles*, *supra* note 137; Hrdy et al., *supra* note 171 (replying to Sussman); and sources compiled in both INFANTICIDE, *supra* note 79, and INFANTICIDE & PARENTAL CARE, *supra* note 64.

305. A more thorough discussion of the shifting burdens of persuasion is beyond the scope of this Article. Useful observations appear, for example, in Browne, *Sex and Temperament*, *supra* note 3, at 975-76, 1105. Some appear to believe that the burden of persuasion falls the other way. *See, e.g.*, Jean Giles-Sims & David Finkelhor, *Child Abuse in Stepfamilies*, 33 FAM. REL. 407, 410 (1984) (a non-biological theory is "more parsimonious" because it does not require a biologically based assumption); Unnithan, *Historical and Anthropological Research*, *supra* note 221, at 154-55 (suggesting that biological theories of child abuse behavior, not non-biological ones, bear the burden of persuasion).

306. Such distinguishing elements must be identified with specificity. While their power to distinguish must be evaluated in a fashion familiar to lawyers (analogous to weighing precedential value in legal contexts), constant vigilance against self-aggrandizing species bias will require evidence grounded in empirical research—not mere appeals to common faith in the *sui generis* nature of humanity.

307. Biologists draw a useful distinction between "homology," the possession by two or more species of a trait derived from a common ancestor, and "homoplasy," possession by two or more species of a similar trait that has not been derived by both species from a common ancestor. *See* FUTUYMA, *supra* note 14, at 295-99. Some traits humans share with other animals may therefore in fact exhibit homoplasy rather than homology.

human animals. In such a circumstance, assessing the relative probable applicabilities of the different theories to humans requires vigilance for potentially distinguishing differences between human evolution and that of related apes, or between the apes and other primates, or between primates and non-primates.

To take but one example that we will return to repeatedly, note that both the *DPS Theory* and the *Reproductive Access Theory* predict that a non-parent is more likely to abuse a juvenile than will either of that juvenile's genetic parents. This accords with the overwhelming bulk of empirical evidence, in humans and non-humans alike. In addition, the *Reproductive Access Theory* predicts that, in species characterized by lactational amenorrhea, males with potential reproductive access to a nursing female will be more likely to target the nursing infant with abusive behavior than they will be to target non-nursing juveniles of the same female. This, too, accords with the empirical research in relevant human and non-human species. In humans, in fact, stepfathers are dramatically over-represented among adults who abuse children, and infants are over-represented among stepchildren who die of abuse.[308]

The question is: Why? Parsimony suggests that at least part of this pattern of increased relative risk of abuse in stepfather homes can be explained, at least in part, by either the *DPS Theory* or the *Reproductive Access Theory*. Each theory can account for the observed patterns without positing even higher reasoning, let alone any other distinctly human assumptions, but which theory better describes reality? Might they both be at work? On one hand, males targeting unrelated infants could be influenced by narrowly tailored infanticidal predispositions posited by the *Reproductive Access Theory*, similar to those apparently present among langur monkeys and other primates. On the other hand, the sex bias among stepparent abusers might be observable as a general by-product of *DPS* alone, played out in typical human mating systems. Human infants, for example, as distinct from human children generally, rarely *have* stepmothers (since they tend to travel with the mother upon separation of the parents)—and this alone might account for the significant sex bias among child-killing stepparents.[309]

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308. *See* Daly & Wilson, *Reply to Gelles*, *supra* note 137; Martin Daly & Margo Wilson, *Stepparenthood and the Evolved Psychology of Discriminative Parental Solicitude* [hereinafter Daly & Wilson, *Stepparenthood*], *in* INFANTICIDE & PARENTAL CARE, *supra* note 64, at 121, 129-30.

309. *See* Daly & Wilson, *Differential Attributes*, *supra* note 298, at 208. As the authors note, some of this bias may derive from the fact that few very small children ever reside

Put another way, one could reason that human children are targeted not because they are stepchildren *per se* but rather because they do not signal the sequence of stimuli that typically evoke parental care.[310] A differential risk of violent lapses of parental solicitude might therefore be "just one, relatively extreme, consequence of the fact that genetic parents' solicitude generally exceeds that of stepparents."[311] If this were true, human males (disproportionately likely to be substitute parents) may be slightly more likely to abuse or even kill unrelated infants *not* because it is *affirmatively* adaptive to eliminate unrelated and needy children of a potential mate, but instead as a mere epiphenomenon (adaptive *or* otherwise) of the fact that natural selection has generally penalized "squandering parental resources on nonkin."[312]

Ordinarily, choosing between competing evolutionary theories will be necessary only if they generate predictions that truly conflict. Such a conflict, if unresolvable on existing evidence, will suggest another component of a future research agenda. In the meantime, a preference between the two theories is required only if they may lead to different legal approaches in *The Application Stage*, when a policymaker may attempt to influence or effect a legal policy in one way or another. Even before such a conflict may ripen, however, it will nonetheless be useful to weigh various physical, emotional, and social differences between humans and non-humans that may suggest that one evolutionary theory *probably* has greater vitality than the other (even where both may operate together). This, in turn, will require a step-by-step reevaluation of the various premises necessary to make either theory true.

For example, the effect of lactational amenorrhea on inter-birth intervals is a necessary, and satisfied, predicate of any applicability to humans of the *Reproductive Access Theory*. However, the theory

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with stepmothers. *See id.* Most stepparents (91%) are men. *See* POPENOE, *supra* note 126, at 33; U.S. BUREAU OF THE CENSUS, DEP'T OF COMMERCE, CURRENT POPULATION REPORTS, MARRIAGE, DIVORCE, AND REMARRIAGE IN THE 1990'S, at tbl.L (1992) [hereinafter MARRIAGE, DIVORCE, AND REMARRIAGE].

310. *See* Richard D. Alexander, *The View from the President's Window*, NEWSLETTER OF THE HUM. BEHAV. AND EVOLUTION SOC'Y (Human Behavior and Evolution Soc'y, Ann Arbor, Mich.), Sept. 1995, at 1, 1-2 [hereinafter Alexander, *The View*] (citing Richard D. Alexander, *Evolutionary Approaches to Human Behavior: What Does the Future Hold?, in* HUMAN REPRODUCTIVE BEHAVIOUR, *supra* note 104, at 317, 333-34).

311. Daly & Wilson, *Differential Attributes*, *supra* note 298, at 208.

312. Daly & Wilson, *Abuse and Neglect of Children*, *supra* note 160, at 406. Parents that allocate a substantial proportion of their investment to non-kin will transmit fewer copies of their own genes into future generations than will parents that discriminate against non-kin in their provision of resources. *See supra* text accompanying notes 84-89.

would be expected to have greater vitality among species in which the average tenure of male access to a female is short, as it is in lions and langurs, than when the average tenure is far longer, as it is in humans.[313] This distinction alone may be enough to distinguish, as have several theorists, the applicability of the *Reproductive Access Theory* in the human context from its applicability in non-human contexts.[314] Moreover, the widely documented and substantial differences among the social organizations of primate species[315] suggests further caution, and recommends that the more general *DPS Theory* may better explain observable, human stepfather infanticide.

5. Should the Theories Be Considered in Legal Analysis and Policy-Making?

If a theory-evidence fit appears tight, and if no compelling analysis concludes that natural selection was unlikely to have influenced the modern manifestation of the defined behavior, we are faced with the following situation, which typifies this fifth step of *The Information Stage*. On one hand, we have the various and traditional prevailing theories that purport to explain the behavior under study. On the other hand, we have a newcomer—a theory judged robust, which purports to have identified evolutionary influences on the origin and persistence of the behavior. The question now is whether the new theory should be taken seriously and included in that group of theories considered by policymakers who are interested in pursuing the stated objective by, in part, affecting the incidence of the defined behavior.[316]

Deciding whether to include a robust evolutionary theory regarding evolutionary influences on the target behavior requires a clear standard of review. Having observed a tight theory-data fit, we

313. The shorter the access to a female, the greater natural selection will favor quick impregnators over slower impregnators.

314. *See* Alexander, *The View*, *supra* note 310, at 2; Buss, *supra* note 1, at 9; Daly & Wilson, *Child Abuse and Other Risks*, *supra* note 288, at 207; Daly & Wilson, *Reply To Gelles*, *supra* note 137, at 421-22; Daly & Wilson, *Risk of Maltreatment*, *supra* note 298, at 216-17; Daly & Wilson, *A Sociobiological Analysis of Human Infanticide*, *supra* note 222, at 502. *But see* Van Schaik & Dunbar, *supra* note 217 (concluding that human pair-bonding, itself, is likely an adaptive response to evolved predispositions to selective infanticide).

315. *See, e.g.*, Frans B.M. de Waal, *Bonobo Sex and Society*, SCI. AM., Mar. 1995, at 82, 85.

316. Note that it is not necessary to decide whether a legal approach to the behavior *should* reflect the theory. That would depend on a later assessment about whether any probable benefits of modifying policies in light of evolutionary analysis outweigh any probable costs of doing so. *See infra* Part II.D.3.

must decide at the outset where the burden of persuasion must fall, and thus what the default result will be. There are only three viable options: 1) a rebuttable presumption that the evolutionary theory regarding the behavior should be included; 2) a rebuttable presumption that the evolutionary theory should not be included; or 3) no presumption at all. Of these, the first is best: There should be a rebuttable presumption in favor of including a robust evolutionary theory in that group of theories considered by legal policymakers.

We employ this same presumption in nearly every other area of intellectual endeavor, reflecting a ubiquitous and facially sound belief that understanding the history of a thing will usually aid a comprehensive understanding of the thing itself. In the fields of politics, business, technology, philosophy, psychology, literature, music, and art, for example, we unpausingly presume that the past is relevant to the present, and that ignoring cross-time perspectives on the emergence of modern phenomena can forfeit valuable insights and precipitate erroneous beliefs. Entire careers in law, for example, have been built on the perceived utility of understanding legal history.

The history of behavior is similarly important to an understanding of modern behavior. Humans will always behave in ways powerfully affected by their unique experiences. Nevertheless, we still must properly presume that behavioral patterns emerging from the cumulated behavior of vast groups of individuals will predictably reflect the subtle but strong presence of a shared history of experiences—whether a language, a culture, or a common biological heritage. Understanding human behavior, some of which is law-relevant, therefore necessarily requires some knowledge of human history as well as individual history. Fundamentally, evolutionary theories are about human history—a deeply contextual history that looks back in time to the processes that influenced the origins and spread of behaviors through populations and generations long before humans manifested the form in which we know them today.

We therefore should presume that a robust evolutionary theory of behavior should be considered in legal analysis, in the absence of a strong showing to the contrary. For example, when we ask whether the apparently robust evolutionary theories concerning the existence and persistence of infanticide should be included alongside other theories and information considered by policymakers charged with affecting the incidence of child abuse, the appropriate presumption is that they should. Evolutionary theories can lay no automatic claim to being superior to any other theory, and their relationship to other

theories is taken up in the next stage. But their robustness, as well as their essentially historical nature, makes them sufficiently relevant to preclude ignoring them.

Consequently, as a product of the *Identification* and *Information* stages of evolutionary analysis, we will carry forward, into the remaining stages of this model's demonstration, the *DPS* and *Reproductive Access* theories, with somewhat greater emphasis on the former.

6. Summary

In sum, this *Information Stage* provides an outline for that part of evolutionary analysis in law that explores evolutionary theories relevant to the legal goal. Specifically, it provides a series of questions that guides one in identifying the evolutionary theories and the predictions they generate, examining cross-species evidence that bears on the accuracy of those predictions, and assessing how well the evidence fits the theories. In addition, it facilitates critical consideration of how well the theories apply in the human context, and of whether to include any evolutionary theories in legal decision-making processes.

To demonstrate how these questions might be answered in a specific context, this section carried forward the child abuse example introduced in stage one—narrowing it, for brevity's sake, to the specific context of infanticide. It introduced several evolutionary theories underlying ultimate causes of infanticidal behavior, detailed a number of predictions generated by two of those theories, examined evidence from non-primate, non-human primate, and human species bearing on the accuracy of those predictions, and determined that available evidence fit the theories very tightly. This section also demonstrated why at least one of the evolutionary theories (*The DPS Theory*) was likely to apply in the human context, and argued that, in such a case, it should be considered along with other theories that policymakers assess when proposing means to pursue the specific legal goal of reducing child abuse.

As we turn to examine the third major stage of proposed model evolutionary analysis in law, we will continue to carry this example forward.

C. *The Integration Stage*

Deciding to include an evolutionary theory in the decision-making processes by which law pursues a pre-determined goal does not automatically suggest how to do so. Evolutionary theories and

prevailing theories may combine or they may clash, and one must assess the extent to which the two are compatible before intelligently considering the utility and importance of either. The third stage of the model here proposed, *The Integration Stage,* therefore asks two questions: 1) Where, if anywhere, do prevailing and evolutionary theories conflict?; and 2) How may their non-conflicting elements, if any, be integrated? Throughout, the purpose of this stage will be to coordinate systems of knowledge that previously developed independently, so as to improve the accuracy and comprehensiveness of society's collective understanding of the complex causes of law-relevant behavior.

1. Where Do Prevailing and Evolutionary Theories Conflict?

Conflicts between prevailing and evolutionary theories are a subset of their differences, and differences might usefully be divided into the constitutive and the predictive. That is, I believe that to begin identifying true conflicts between the theories one should first divide the differences concerning the theoretical substructures of the theories (the constitutive) from the differences concerning the predictions they generate (the predictive). We take these in sequence.

a. Conflicts Between Theoretical Substructures

The theoretical substructures of prevailing and evolutionary theories are simply their conceptual bases and most fundamental elements of orientation and logic. Two kinds of differences between the theoretical substructures of prevailing and evolutionary theories, in turn, are likely to be identified: 1) differences in their levels of analysis; and 2) differences in their basic assumptions.

(1) Differences in Levels of Analysis

Differences in levels of analysis may obtain because an evolutionary theory is necessarily a theory about ultimate causation (the "whys" of behavior—where it comes from and why it persists) while prevailing theories are usually theories about proximate causation (the "hows" of behavior—how it is triggered into being and effected). Theories of ultimate causation and theories of proximate causation, though related, operate at fundamentally different levels of analysis, and to some extent reflect ancient and artificial disciplinary boundaries.

People often presuppose that the differences between evolutionary and non-evolutionary theories must yield a winner-take-all conflict (as if a prevailing, non-evolutionary theory must vanquish a

usurping evolutionary theory or die a miserable death). But this supposed conflict, as illogical as it is melodramatic, is rarely a true conflict at all.[317] In fact, ultimate and proximate influences on behavior are opposite sides of the very same coin, coexisting without necessary conflict. Ultimate causation simply explains why certain environmental factors, and not others, are *likely* to be proximate causes of behavior, and provides the sort of intellectual coherence that makes the association between certain environmental factors and certain behavior more fully understandable. Thus, absent evidence to the contrary, one should begin from the presumption that a given evolutionary theory is compatible with prevailing theories, not the opposite.[318]

More specifically, by failing to first identify differences in levels of analysis between prevailing and evolutionary theories on child abuse, for example, many have understandably confused fully compatible explanations with alternative ones. Prevailing theories on child abuse, including theories on infanticide, are principally sociocultural. With only rare exceptions, child abuse is considered the result of some complex interplay of exclusively social forces—including the current and uniquely summed influences of family, friends, and community written against a background of individual experience that is colored by prior events, perceptions, and behavioral interactions. Evolutionary theories regarding why animals have and raise or neglect offspring in the patterns they do, on the other hand, suggest shared, species-typical predispositions. Those few scholars of prevailing theories on child abuse who even mention evolutionary theory in the context of stepparent abuse (to continue with that specific example) tend to present it as an *alternative* to sociocultural theories and to cast it in a necessarily competitive role.[319] Evolutionary explanations are implied to be completely different and independent of prevailing theories that may locate causal factors in, for instance, the frequent inability of stepparents to feel the same sense of "loyalty

317. This conflict echoes the false and silly "nature versus nurture" dichotomies explored earlier. *See supra* note 105 and accompanying text.

318. *See generally* Alcock & Sherman, *supra* note 16, at 60-61 (arguing that proximate and ultimate explanations should be considered complementary); *see also* notes 15-20 and accompanying text (explaining ultimate and proximate causes in the biological context).

319. *See, e.g.*, Marilyn Coleman, *Stepfamilies in the United States: Challenging Biased Assumptions*, *in* STEPFAMILIES, *supra* note 126, at 29-31 (attacking invocation of evolutionary theories of stepparent mistreatment of stepchildren). *But see* POPENOE, *supra* note 126, at 7-10 (incorporating evolutionary perspective into analysis of child abuse); McGuire & Gelles, *supra* note 126 (same).

and belonging" as do genetic parents.[320]

The reason this fabricates conflict where none exists is because the two causal theories—ultimate, on the one hand, and proximate, on the other—*do not butt heads in the same plane of analysis*.[321] Not only do the evolutionary theories generally not compete with the prevailing theories, the evolutionary analysis in fact *predicts* that adults will generally not feel as solicitous of unrelated offspring as they will of their own. For beneath Prediction 6 above ("Children will be at greater risk of infanticide in stepparent households than in natural parent households") lies the logic that the marginally increased probability of abuse of unrelated children will accompany a variety of subjectively perceived emotional states correlated with decreased solicitude. Mistaking differences in levels of analysis for true conflicts will impede integration by fostering a presumption of incompatibility, rather than the proper (but rebuttable) presumption of compatibility of the theories.

(2) Differences in Basic Assumptions

By the "basic assumptions" of prevailing and evolutionary theories, I refer to those logical predicates, presupposed to be true, upon which and around which the evolutionary and prevailing theories are built and shaped. Again, not all such differences are conflicts. But, unlike differences between levels of analysis, which rarely, if ever, are for that reason alone conflictual, differences between basic assumptions will sometimes be mutually exclusive, so that only one can be right. (An obvious, though non-biological, example of this: Theory X assumes the Sun revolves around the Earth; and Theory Y assumes the Earth revolves around the Sun.) True conflicts between basic assumptions will generally recommend the search for testable differences between the theories' predictions.

It might appear that a true conflict between theories would arise whenever they maintained exactly opposite assumptions. However, this is not always the case, and one should remain alert to false conflicts seemingly attributable to opposing assumptions. For example, evolutionary theories assume that evolutionary processes influenced, and continue to influence, significant human behaviors.[322] Non-

320. *See, e.g.*, Marilyn Ihinger-Tallman, *Research on Stepfamilies*, 14 ANN. REV. SOCIOLOGY 25, 39 (1988).

321. "Evolutionary theory is not a substitute for psychological analysis, but a valuable aid thereto. . . ." Wilson & Daly, *The Psychology of Parenting in Evolutionary Perspective*, *supra* note 155, at 96.

322. It is important to stress that evolutionary theorists are not trying to locate the

evolutionary theories, by omitting consideration of any effect of natural selection on studied behavior, often implicitly presuppose that evolutionary processes *did not and do not* operate to significantly influence modern, law-relevant human behaviors. Despite these opposing assumptions, however, this is not a true conflict. The apparent conflict is simply a function of what we might call "exclusionary biases," rather than "exclusionary necessities." Exclusionary bias is present when proponents of a non-evolutionary theory intentionally or in effect exclude the possibility of evolutionary influences when such exclusion is not a logically necessary predicate of the non-evolutionary theory—in other words, when the non-evolutionary theory does not *require* that evolutionary processes *not* influence human behavior.[323] Even opposing assumptions can appear to be mutually exclusive without in fact being so.

Prevailing theories on why stepparents abuse children more than genetic parents, for example, are intricate constructs of environmentally determined causality. But their assumption of "no evolutionary influence" is a function of an *exclusionary bias*, rather than an *exclusionary necessity*. Indeed, it is not necessary to the theory that abuse can flow from stepparental "role confusion" (on which more will be said shortly) that the affectional impediments such confusion may cause be entirely *non*-evolved. Only the well-worn grooves of disciplinary boundaries, and the exclusionary bias they evidence, have established a tradition of assuming no evolutionary influence. Nevertheless, the difference between these basic assumptions of prevailing and evolutionary theories of stepparental abuse, at least, are not necessarily in conflict.

b. Conflicts Between Predictions

Identifying differences between the predictions of prevailing and evolutionary theories requires careful comparisons, with attention to particularity and with vigilance for similarities, overlaps, divergences, and inconsistencies. Under this approach, differences between predictions generated by evolutionary and non-evolutionary theories will

genetic basis for behavioral traits. Evolutionary biologists are not generally focused on the developmental (proximate) bases of behavior. Nevertheless, their discipline inevitably relies on the fact that there have been genetic differences among individuals in the past that have resulted in different developmental trajectories (and thus characteristics) that are then subject to natural selection.

323. Another way of saying this is that the assumption on which the conflict appears to rest is not truly basic to the non-evolutionary theory. Because it is in reality tertiary, it could be modified to include some role for natural selection without eviscerating the non-evolutionary theory.

be considered conflictual if and only if the theories generate two predictions that cannot both be true at the same time (*a, b, c*, and *a, b, not c*, respectively). Otherwise, and more often the case, the theories are compatible because: 1) they generate the same predictions (*a, b, c*, and *a, b, c*, respectively); 2) they generate different but not conflicting predictions (*a, b, c*, and *x, y, z*, respectively); 3) they generate overlapping predictions, where the overlapping predictions are identical (*a, b, c*, and *a, b, z*, respectively); or 4) one generates all the predictions of the other, as well as more besides (*a, b, c*, and *a, b, c, d, e, f*, respectively).

It would, of course, be useful if the prevailing theories enumerated their predictions in a fashion that allowed direct comparison. But that will rarely be the case, since a great number of non-evolutionary theorists often fail to enumerate falsifiable predictions to test against the evidence.[324] A fair comparison thus requires interpretive efforts. And those in turn require recourse to the general orientation of various prevailing theories in order to approximate and locate any true conflicts in predictive power.

To illustrate: A close examination of the prevailing and evolutionary theories concerning the disproportionate child abuse and infanticide by stepparents, for example, will reveal few, if any, true conflicts. The traditional social-science explanations, on one hand, attribute stepparent abuse to: some combination of stresses supposedly uniquely created by stepfamily life;[325] the tensions attributable to the ambiguity, newness, and conflicting expectations surrounding the stepparenting role; and to the resulting lack of "institutionalized norms."[326] The evolutionary theories, on the other hand, attribute the

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324. Jean Giles-Sims is one of the notable exceptions. *See, e.g.*, Jean Giles-Sims, *Social Exchange in Remarried Families*, *in* REMARRIAGE AND STEPPARENTING: CURRENT RESEARCH AND THEORY 141, 144-50 (Kay Pasley & Marilyn Ihinger-Tallman eds., 1987) [hereinafter REMARRIAGE AND STEPPARENTING].

325. *See, e.g.*, Giles-Sims & Finkelhor, *supra* note 305, at 410-11; Diane Reinhart Kompara, *Difficulties in the Socialization Process of Stepparenting*, 29 FAM. REL. 69, 70-72 (1980); articles collected in REMARRIAGE AND STEPPARENTING, *supra* note 324.

326. Jean Giles-Sims, *The Stepparent Role: Expectations, Behavior and Sanctions*, 5 J. FAM. ISSUES 116, 117 (1984); *accord* Andrew Cherlin, *Remarriage as an Incomplete Institution*, 84 AM. J. SOCIOLOGY 634 (1978); Giles-Sims & Finkelhor, *supra* note 305, at 410-11; Jamie Kelem Keshet, *Cognitive Remodeling of the Family: How Remarried People View Stepfamilies*, 60 AM. J. ORTHOPSYCHIATRY 196, 197 (1990); Kompara, *supra* note 325 (summarizing the literature); Mary Ann Mason & David W. Simon, *The Ambiguous Stepparent: Federal Legislation in Search of a Model*, 29 FAM. L.Q. 445, 467-72 (1995); Kay Pasley & Marilyn Ihinger-Tallman, *The Evolution of a Field of Investigation: Issues and Concerns*, *in* REMARRIAGE AND STEPPARENTING, *supra* note 324, at 303, 309-11; Kay Pasley, *Family Boundary Ambiguity: Perceptions of Adult Stepfamily Members*, *in* REMARRIAGE AND STEPPARENTING, *supra* note 324, at 206, 221; *see also* CHILDREN'S

distinctive patterns of stepparent abuse to discriminative parental solicitude or evolutionary pressures to behave in ways that speed reproductive access, or both. *Both* sets of theories predict that raising an unrelated child will be somewhat more stressful than raising a related child.[327] And while the "role confusion" theory suggests that stepparent abuse will diminish substantially as "divorce and remarriage become more common [and] institutionalized standards for conduct in reconstituted families ... emerge,"[328] the evolutionary theories, while different in focus, are not contrary. While they acknowledge the important influence of cultural norms on human behavior, they simply predict that the patterns of stepparent abuse, as a product in part of evolved psychology that links emotional states with motivations, may be even more difficult to overcome than the prevailing theories suggest.

2. How May Non-Conflicting Elements Be Integrated?

In this final step of *The Integration Stage*, one should carefully

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DIV., AM. HUMANE ASS'N, GUIDELINES TO HELP PROTECT ABUSED AND NEGLECTED CHILDREN (June 1993) (proclaiming that child abuse "usually reflects the inadequacy or incapacity of parents to live up to parental roles"); Daly & Wilson, *Risk of Maltreatment, supra* note 298, at 216-21 (discussing social science perspectives).

327. Much information from the vast literature on dissatisfactions with stepfamily life seems to support this proposition. *See, e.g.*, LUCILE DUBERMAN, THE RECONSTITUTED FAMILY: A STUDY OF REMARRIED COUPLES AND THEIR CHILDREN (1975). As Daly and Wilson note in *Stepparenthood*, *supra* note 308, both stepchildren and stepparents generally consider their relationships to be less satisfying and loving, and less supportive (both materially and emotionally), than genetic parent-offspring relationships. *See id.* at 131; *accord* ELSA FERRI, STEP CHILDREN: A NATIONAL STUDY 46 (1984); Judith Zucker Anderson & Geoffry D. White, *An Empirical Investigation of Interaction and Relationship Patterns in Functional and Dysfunctional Nuclear Families and Stepfamilies*, 25 FAM. PROCESS 407, 409 (1986); Terry F. Perkins & James P. Kahan, *An Empirical Comparison of Natural-Father and Stepfather Family Systems*, 18 FAM. PROCESS 175, 176 (1979); John W. Santrock & Karen A. Sitterle, *Parent-Child Relationships in Stepmother Families*, *in* REMARRIAGE AND STEPPARENTING, *supra* note 324, at 273, 274; Lynn K. White & Alan Booth, *The Quality and Stability of Remarriages: The Role of Stepchildren*, 50 AM. SOC. REV. 689, 695-96 (1985). Stepparents do not generally feel the same child-specific love and commitment as genetic parents, nor do they perceive the same emotional rewards from their parental investment. *See* Daly & Wilson, *Risk of Maltreatment, supra* note 298, at 218. For example, researchers have found that only 53% of stepfathers and only 25% of stepmothers claimed "parental feeling" toward their stepchildren and even fewer claimed to "love" them. *See id.* Furthermore, both marital partners in stepfamilies indicate they are looking forward to the children's departure, and stepchildren do in fact leave home at an earlier age than those living with natural parents. *See* Joseph H. Rankin, *The Family Context of Delinquency*, 30 SOC. PROBS. 466, 475 (1983); White & Booth, *supra*, at 695, 696-97. Incidentally, the ubiquity of neglecting or abusing stepparent stories in folklore is surely not coincidental. *See* 5 STITH THOMPSON, MOTIF-INDEX OF FOLK-LITERATURE 300-02 (1955) (compiling folk tales about cruel step-relatives).

328. Giles-Sims, *supra* note 326, at 127.

test and compare the prevailing and evolutionary theories where they do conflict, and integrate them where they do not. Where evolutionary and prevailing theories truly do conflict (that is, where their theoretical substructures or predictions are mutually exclusive), an evolutionary theory will either be better than, equal to, or worse than a prevailing theory. The evolutionary theory can only be judged somehow "better" in two circumstances: 1) if its predictions are more consistent with observable patterns of behavior than are those of the prevailing theory (in which case the evolutionary theory has more "predictive power"); or 2) if it achieves an equal predictive power with fewer or simpler assumptions (in which case the evolutionary theory is more "parsimonious"). If either of these circumstances obtains, the evolutionary theory can represent anything from a marginal improvement to a thoroughly new paradigm for understanding the behavior. Less predictive power, or equal predictive power predicated on either more or more complex assumptions, renders an evolutionary theory "worse," in which case it should be refined or discarded. In contrast, when an evolutionary theory is more or less "equal," that is, if neither appreciably better nor worse, both theories should be pressed for narrower testable—and then tested—predictions.

Where evolutionary and prevailing theories do not conflict, one should attempt to blend them into an integrated whole. This requires that one at least temporarily marginalize the vague, unspecific, or disconnected elements of the theories, and then seek to construct a coherent partnership of ultimate and proximate causation that vindicates any unseverable connections between them. Successful integration requires, for example, that one look to align related predictions of the different theories in order to nest the more general predictions into the more specific ones, to the extent consistent with the facts.[329] Demographic predictors usefully identified by sociology, for instance, by sex, age, marital status, and the like, may be folded into more specific predictors, where they exist, generated by evolu-

329. Although there may be many points of common connection between evolutionary and non-evolutionary theories, it is important to recognize that it is not necessary for the partnership to succeed that all resultant explanatory models showily display specific evolutionary theories. So long as the integrated model is written against the backgound of the general, or meta-level, evolutionary theory, it may command as much of the contemporary, uniquely modern foreground as required by the strictures of science. The partnership need not be 50/50 with respect to the behavior under study, for sound behavioral theories will manifest a diversity of ratios reflecting the centrality or relative unimportance of specific evolutionary theories to a modern understanding of the behavior, as it operates in a distinctly modern world.

tionary theories. The point of integration is to construct a unified, coherent, interwoven, historically accurate, and generally superior theory of the behavior that impedes or furthers social access to the specified goal.

For example, there are at least four ways in which evolutionary theories can combine with prevailing theories to yield better theories. First, they can provide across-time context, helping to uncover additional causal influences beyond the boundaries of that sliver of time from the birth of an abusive parent to the incident of abuse. Patterns thought recent appear ancient, as we learn that our ancestors acted in ways often detrimental to juveniles long before the emergence of a distinctly hominid brain or modern mind. Scrutiny of the present, to the exclusion of the past, will fail to see the behavior in the full social context its unique evolutionary history created.

Second, evolutionary theories can provide across-species context, helping to avoid segregation errors owing to any unjustifiably exclusive obsession with our own species. Theories that focus overnarrowly on humans can fail to see human behavior as, by definition, only a variation of animal behavior, and must largely forgo the often relevant and useful body of empirical and theoretical work respecting the rest of the animal kingdom.

Third, evolutionary theories can help to remedy instances of biologically naive environmental determinism, which may otherwise over-aggrandize the human species. Theories presupposing that child abuse can be comprehensively explained by only cultural roles, expectations, experiences, and socialization processes, for example, are likely to miss important aspects of the many and complex influences underlying abusive behavior. They are therefore similarly likely to overestimate somewhat the malleability of human behavior.

Fourth, and perhaps most importantly, evolutionary theories can balance proximate causes of child abuse with evolutionary causes. Prominent child abuse researchers acknowledge that even theories popularly reputed to explain "*why* a parent might abuse a child"[330] typically perform a more limited function: identifying "marker variables associated with abuse," rather than a theoretical framework to *explain* those associations.[331] For example, researchers have argued that because abused and neglected children are disproportionately premature, of low birthweight, mentally retarded, physically or sen-

330. *See, e.g.*, WOLFE, *supra* note 118, at 56.

331. *See* Richard J. Gelles, *Physical Violence, Child Abuse, and Child Homicide: A Continuum of Violence, or Distinct Behaviors?*, 2 HUM. NATURE 59, 67 (1991).

sorily handicapped, or subject to the care of substitute parents, the stresses caused by these conditions must cause the abuse.[332] While useful, however, these observations can offer no full explanation for *why* these correlations occur—why, for example, parents perceive *these* environmental facts (and not others) as stressful, or why these stressors increase the likelihood of *child abuse* (and not of kite-flying).[333] They are theories of proximate causation unsupplemented by the richer understanding of the ultimate causes of child abuse that only evolutionary analysis can provide.

Evolutionary theories can therefore help to complement and supplement those prevailing theories with which they do not conflict. Gracefully enmeshing the two kinds of theories, at the two different levels of analysis, will require narrower statements of predictions (as biology reins in occasionally overbroad speculation of sociocultural theories) and more thoughtfully rearticulated evolutionary theories (as the latter are met by sometimes challenging data collected within the more human-obsessed social sciences). The key to integrating evolutionary and prevailing theories is in recognizing that the evolutionary pressures of our deep ancestral past have shaped human neural architecture and concomitant behavioral predispositions in ways that often yield *precisely* the emotional realities that prevailing theories associate with the behavior under study. For example, evolutionary analysis enables us to step back and see stepparental infanticide within the larger context of human infanticide, infanticide itself within the larger context of child abuse and neglect, and the latter, in turn, as but a single motif within longer and larger patterns of human behavior—that span reproductive strategies and reflect the relentless pressure of natural selection to increase reproductive success. The advantages this provides to our efforts to stem child abuse (explored in the next stage) will be paralleled with respect to many other law-relevant behaviors and the legal policymaking challenges they create.

3. Summary

In sum, this *Integration Stage* provides an initial outline for that part of evolutionary analysis in law that follows when a given evolutionary theory on law-relevant behavior is sufficiently robust, and

332. *See* Ammerman, *supra* note 118, at 203.

333. *See, e.g.*, Giles-Sims & Finkelhor, *supra* note 305, at 410 (observing, in the context of stress theory, only that "it is well-documented that stepfamilies experience stress, and that stress is *related* to child abuse" (emphasis added)).

sufficiently likely to apply to humans, that it should be included along with other theories and information to be considered by legal policymakers. Specifically, this stage asks two questions. First, it asks where, if anywhere, do prevailing and evolutionary theories conflict. The model proposes that differences between theoretical substructures (i.e., levels of analysis and basic assumptions) be distinguished from differences between the predictions of the respective theories. This helps to narrow the set of apparent conflicts to only the true conflicts. Second, it asks how the non-conflicting elements, if any, of the respective theories can be integrated. The model proposes that related predictions be aligned, and that logical connections between proximate and ultimate causes be drawn and tightened.[334]

To demonstrate concretely how these two questions might be answered in a specific context, this section carried forward the child abuse example introduced in the first stage (narrowing it, for illustrative purposes, to the specific context of infanticide and occasionally, within that context, to infanticide committed by adults unrelated to the victim). The important point is that because human psychology tends to reflect an adaptive logic, integrating ultimate and proximate causation analyses will tend to improve behavioral models—increasing their predictive power and rendering them more accurate, more subtle and sophisticated, more embracing of the complexities of human existence, more dimensional, and more fully contextual. Ultimately, of course, the value of such integration will be evident only through application.

D. The Application Stage

The Identification Stage of the model helps to define a specific legal goal and to assess the likelihood that evolutionary analysis will prove worthwhile. *The Information Stage* of the model guides an examination and assessment of theory and evidence concerning possible evolutionary influences upon specific human behavior impeding or facilitating pursuit of the legal goal. *The Integration Stage*, in turn, provides a process to determine the proper relationship between a robust evolutionary theory and a prevailing theory. In the fourth and final stage, *The Application Stage*, evolutionary analysis must pay its way. The process of integrating evolutionary theories with prevailing theories may prove useful in at least four ways:

334. The integration process is explored at greater length in Owen D. Jones, *Law and Biology: Toward an Integrated Model of Human Behavior*, 8 J. CONTEMP. L. ISSUES (forthcoming May 1997).

1) refining behavioral models that predict the statistical incidence of the behavior; 2) generating new social and legal strategies for addressing the behavior; 3) clarifying cost-benefit analyses regarding the implementation of legal policies; and 4) pointing future research in promising directions.

1. How Can Evolutionary Analysis Help To Refine Behavioral Models?

a. How It Can Help

Behavioral models attempt to explain the incidence of certain behaviors. Because the primary purpose of a legal system is to regulate human activity—by discouraging some behaviors and encouraging others—the legal system can ultimately be no more effective than the behavioral models on which its regimes depend. Indeed, the first of four important applications of evolutionary analysis involves improving these models by: 1) integrating the proximate and ultimate causes of behavior; 2) identifying relationships between the behavior and previously unidentified environmental factors; 3) helping to define with more precision those previously identified environmental factors already associated with the behavior; and 4) generating predictions about how various associated environmental factors may interact.

First, by integrating proximate and ultimate causes of behavior, evolutionary analysis encourages a more holistic and accurate understanding of the origins of human behavior. It adds historical dimension, and facilitates a deeper appreciation of the complex and dynamic interaction of genetic and environmental factors that affect the behaviors law seeks to regulate. Evolutionary analysis prompts us to anticipate that natural selection will have left humans today with behavioral predispositions that tended to increase individual inclusive fitness in ancestral times. Consequently, it enables us also to anticipate that these evolved predispositions will now be generally more widespread in current populations than would be various contemporaneously existing alternative predispositions that had less beneficial effects, on average, on individual reproductive success. This insight will often reveal opportunities to improve prevailing theoretical models, and thus those aspects of law that base remedial policies upon them.

For example, evolutionary analysis provides both a broader and more subtle understanding of adult-infant relations, which in turn lets us see child abuse in a larger context. It makes plain that parental

care, and the subjective motivational states that prompt it, evolved as part of an evolutionarily adaptive reproductive strategy. In humans, as in other animals employing parental care, we expect the majority of parents to exhibit an evolved discriminative parental solicitude, in the form of generally adaptive emotional predispositions (such as, in humans, feelings of parental love) that tend to bias a parent's resources toward genetic offspring at the expense of non-offspring, and toward those children likely to contribute most to parental inclusive fitness. We know, of course, that such predispositions will not automatically cause any particular behavior in any individual person, because a wide variety of highly significant and additional factors (such as religion, thoughtful analyses of distributive fairness, and the like) also mediate human motivations. But, to the extent that what we call child abuse can be seen as something of an inverse of parental solicitude, and to the extent that behavioral predispositions will by definition affect behavior on the margin, evolutionary analysis suggests that diminished solicitude will correlate positively, in a society of millions, with increased abuse and neglect—even with infanticide. Evolutionary analysis therefore exposes as anachronistically naive the prevalent theoretical assumption, underlying many social and legal efforts to reduce child abuse, that "normal" parents will treat each of their own children with roughly equal love and care. It suggests that our normative preference for that to be the case has heavily influenced our supposition of "normality"—causing us perhaps to assume that *normal* adults will exhibit the emotional responses we *wish* they would.

Second, because many adaptive behavioral predispositions are highly context-specific, evolutionary analysis will often identify new connections between specific proximate environmental factors (let us call these "associated environmental factors") and law-relevant behavior. That is, by enabling us to recognize that certain associated environmental factors will have created selective pressures that in the past favored the evolution of certain behavioral predispositions, evolutionary analysis provides the legal system with new or better predictors of the kinds and confluences of environmental stimuli most likely to result in behaviors relevant to the legal system, and enables it to make some judgment as to the relative strength of their influence.

For example, evolutionary analysis suggests that parental solicitude toward children will vary according to the available amount of parental investment, to observable characteristics predictive of each child's probable contribution to parental inclusive fitness, and to the

likelihood that parental investment would earn higher fitness returns if invested elsewhere. It thus suggests that the likelihood of infanticide will therefore also vary as a function of specific parental demographic characteristics, such as sex, age, marital and economic status, genetic relationship to a child, and the like. For instance, it suggests that substitute parents, such as stepparents, will be far more likely per capita to abuse a child than will be natural parents, because the conditions that most easily invoke extraordinary parental solicitude are absent.

Third, evolutionary analysis will enable us to restate with greater precision those connections between environmental factors and behavior of which we may already be aware. For example, we have long known that young mothers are more likely to abuse a child than older mothers. But evolutionary analysis more specifically suggests that, given a population of millions, and where all else is equal, we may expect that the risk a mother will do so will decline rather smoothly across her reproductive years, as a function of the proportion of her remaining reproductive years to her total reproductive years.

Fourth, evolutionary analysis will help us make more accurate predictions than we could otherwise when all else is not equal—as when humans confront combinations of various environmental factors. For example, it suggests that the kinds of "stressors" that traditional social science has identified will be relevant to child abuse in proportion to how significantly the presence of those stressors would have affected human reproductive success not in current environments, but in ancestral ones. The likelihood that a behavioral predisposition will in fact manifest itself will then be partly a function of the number of such stressors that cumulate.

b. Aren't Statistics Alone Enough?

If it is true, for example, that a stepparent is statistically more likely to abuse a child than a natural parent, one might wonder whether we need evolutionary analysis at all. In other cases, as in this one, the descriptive data alone may appear sufficient. Statistics do not compile themselves, however; they are a function of the way we organize and collect data. Those processes, in turn, often reflect presuppositions that may be wrong and that may unintendedly obscure law-relevant behavioral patterns. For example, and in hindsight quite surprisingly, before evolutionary psychologists predicted that stepparents are more likely to abuse, no one bothered to collect data in a systematic way that differentiated stepparents from natural parents,

an obvious prerequisite to analysis of victimization rates and relative risk.[335] Indeed, commentators have recently observed that many who had studied child abuse for decades never thought to rigorously scrutinize the kinship variable.[336]

Such blindspots are not easily remedied. Although evolutionary psychologists studying child abuse called upon official agencies, particularly census bureaus, "to recognize the importance of the distinction between natural and substitute parenthood" more than a decade ago,[337] most studies and reporting procedures that today capture information regarding a perpetrator's relationship to an abused child continue to collapse "stepparents" into the definition of "parents." To cite but a few surprising examples:

- The United States Department of Health and Human Services, in a 1995 report on child abuse, defines "parent" as "the birth mother/father, adoptive mother/father, or stepmother/father of a child."[338]
- When the Inter-Agency Council on Child Abuse and Neglect published the *Child Death Review Team Report for 1994*, part of that report, concerning "Child Homicides by Parents/Caretakers in Los Angeles County," included thirteen Tables and ten Figures of data sorted according to such things as gender of victim, age of victim, ethnicity of victim, types of injury, month of year, reasons for prior Child Protective Services involvement (if any), and the age, sex, and ethnicity of the parent or other caretaker. And yet *all* of

335. *See* Daly & Wilson, *Risk of Maltreatment*, *supra* note 298, at 221-25; Daly & Wilson, *Stepparenthood*, *supra* note 308, at 128-29. Some prior, general studies of child abuse had remarked on the number of child abuse victims in stepfamily homes. *See, e.g.*, DAVID G. GIL, VIOLENCE AGAINST CHILDREN: PHYSICAL CHILD ABUSE IN THE UNITED STATES 117, 140 (1970). But for many years child abuse statistics were quite crude, providing little useful demographic data about characterisitcs of children or parents. *See* Richard J. Gelles, *Violence Towards Children in the United States*, 48 AM. J. OF ORTHOPSYCHIATRY 580, 580 (1978). Moreover, before 1983 no one in either Canada or the United States had any accurate sense or data regarding how many children actually *lived* with stepparents—an obvious prerequisite for any rate-based analysis. *See* Daly & Wilson, *Child Abuse Risk and Household Composition*, *supra* note 294, at 11.

336. *See* RANDOLPH M. NESSE & GEORGE C. WILLIAMS, WHY WE GET SICK: THE NEW SCIENCE OF DARWINIAN MEDICINE 223 (1994).

337. Daly & Wilson, *Child Abuse and Other Risks*, *supra* note 288, at 209.

338. NATIONAL CTR. ON CHILD ABUSE AND NEGLECT, U.S. DEP'T. OF HEALTH AND HUMAN SERVS., CHILD MALTREATMENT 1993: REPORTS FROM THE STATES TO THE NATIONAL CENTER ON CHILD ABUSE AND NEGLECT glossary B-5 (1995) [hereinafter REPORTS FROM THE STATES]. "Perpetrators" are divided into seven categories: 1) parents; 2) other relatives; 3) foster parents; 4) facility staff; 5) child care providers; 6) non-caretakers; and 7) unknown. *See id.* at item 15, at 3-12.

these data lumped genetic parents, stepparents, substitute parents, and other caretakers together.[339] Indeed, the "Relationship of Perpetrators" Table made no distinction between mothers and stepmothers, or fathers and stepfathers.[340]

- The 1996 report of the Bureau of Justice Statistics on *Child Victimizers: Violent Offenders and Their Victims* includes stepchildren in the definition of "Own Child" when describing victim-offender relationships.[341]

Because we cannot see what we do not look for, it is unsurprising that such reports typically conclude, without more particularity, that "[p]arents account for 77 percent of perpetrators."[342] In contrast, an evolutionary analysis' prediction of risk factors such as stepparentage can facilitate the collection of relevant data. The analysis tells us where to look, what to look for, and how to slice the data in ways that may further the pursuit of legal ends.

c. Won't Evolutionary Analysis Often Simply Confirm Common Intuitions?

Evolutionary analysis sometimes will help to explain things people already believe. For example, many undoubtedly believe, even absent evolutionary analysis, that a child will be at greater risk of abuse by a stepparent than by a parent.[343] Yet explanations matter. We routinely suppose that unexplained intuitions (such as those

339. *See* LOS ANGELES COUNTY INTER-AGENCY COUNCIL ON CHILD ABUSE AND NEGLECT (ICAN), ICAN, CHILD DEATH REVIEW TEAM REPORT FOR 1994, at 15-34.

340. *See id.* at tbl.12. Moreover, a suggested model "Child Fatality Review Team Comprehensive Data Set" requires only that investigators specify, for each person commonly involved in the deceased's life and for each suspected perpetrator, only a "relationship to deceased." ANDERSON & WELLS, *supra* note 139, app. C at 6, 10. Nothing in the model data set or its instructions suggests that investigators should identify stepparents as anything other than parents. *See id.* Curiously, the proposed "Minimal Data Set," purporting to be a streamlined version, encourages differentiating stepparent caretakers from genetic parent caretakers, but again requires no such identification with respect to suspected perpetrators. *See id.* item 31, app. B, at 3.

341. *See* BUREAU OF JUSTICE STATISTICS, U.S. DEP'T OF JUSTICE, CHILD VICTIMIZERS: VIOLENT OFFENDERS AND THEIR VICTIMS 10 tbl.13 (1996). This leads to such undifferentiated conclusions as: "Nearly a third of those serving time in State prisons for violence against children had victimized their own child *or a stepchild*." *Id.* at iii (emphasis added).

342. REPORTS FROM THE STATES, *supra* note 338, §2.4, at 2-12.

343. "Cruel stepparent stories are a cross-cultural universal." Gelles & Harrop, *supra* note 126, at 78; *accord* Daly & Wilson, *Risk of Maltreatment*, *supra* note 298, at 215-16 (discussing popular, mythological, and cross-cultural perceptions of stepparents); Daly & Wilson, *Stepparenthood*, *supra* note 308, at 121-22 (same); Gelles & Harrop, *supra* note 126, at 78 (same) (citing M.R. COX, CINDERELLA: 345 VARIANTS (1892); S. THOMPSON, MOTIF-INDEX OF FOLK LITERATURE (1955)).

about stepparents) lack any basis in fact, and then design legal strategies that ignore them or are designed to counteract them. That supposition may often be correct. Nevertheless, evolutionary analysis will sometimes suggest clear causal relationships underlying observable correlations that we suspected, but could not explain, as in the case of stepparental child abuse.[344] That should, in turn, suggest reevaluation of policies presupposing the *absence* of explanation, such as those that may be designed to treat parents and stepparents alike. *While there may of course be independent reasons for law to give no effect to a perceived behavioral pattern*, such as the increased risk of stepparental abuse, evolutionary analysis will often at least make clear that doing so may hinder law's ability to interrupt that pattern.

2. How Can Evolutionary Analysis Help To Generate New Legal Strategies?

Because behavioral models are the foundation of effective legal policies, they limit the number and nature of the possible regulatory interventions from among which policymakers choose. Deficient models yield poor options and poor results. In the second of four applications of evolutionary analysis, then, policymakers equipped with more refined models of the causes of law-relevant behaviors may develop new ways to address them.

A legal system informed by evolutionary analysis might more precisely target, regulate, or otherwise control the existence of, or access to, newly identified associated environmental factors. If environmental factor x increases the likelihood that people in a given society will exhibit behavior y, then one strategy law may pursue to reduce y is to reduce the prevalence of x. Legal systems already do this, but to the extent evolutionary analysis identifies *new* links between such factors and law-relevant behaviors it reveals new avenues for channeling behavior in fashions consistent with pre-articulated social and legal goals.[345] A legal system informed by evolutionary analysis might also design programs that take account of evolved mo-

344. *Cf.* Browne, *Sex and Temperament*, *supra* note 3, at 977-84 (demonstrating how sex differences in behavior may contribute to differential representation among certain kinds of jobs).

345. It is extremely important to recognize that the contribution of evolutionary analysis, in this regard, is fully and functionally compatible with the purposes of the traditional social science theories, which likewise focus their attentions on environmental stimuli. Members of traditional social science disciplines should therefore find evolutionary analysis threatening only if they claim a monopoly on useful analytical techniques.

tivational links between environmental stimuli and behavior by narrowly tailoring legal regimes to interrupt or weaken them. This could involve invoking the panoply of tools available to society, such as social or educational programs targeted at those most likely to experience the stimuli, incentive programs, or refocused deterrence initiatives.

For example, prevailing child abuse policies built on theories unsupplemented by an evolutionary foundation rely on the "critical theoretical assumption [that] [c]hild abuse is a learned behavior that can be conceptualized in social learning terms."[346] As long as one assumes this—that the origins of child abuse lie exclusively in learned behavior—regulatory efforts will over-rely on "learning opportunities,"[347] and overestimate the likelihood of their effectiveness. Thus today, for instance, such social and legal campaigns to eradicate child abuse focus on such things as:

- post-act state interventions, such as termination of parental rights or criminal prosecution;
- developing strong positive habits of child rearing through successful and rewarding parent-child interaction at an early stage of development;
- improving the parent's abilities to cope with stress through exposure to a mental health support system;
- developing the child's adaptive behaviors that will contribute to his or her emotional and psychological adjustment;
- competency enhancement (through parent education programs);
- public awareness campaigns (through information services);
- programs for high-risk groups during periods of transition and stress (such as family support programs);
- child management training;
- parent education and support groups;
- stress management classes;
- community outreach or educational programs; and
- group or individual training.[348]

346. WOLFE, *supra* note 118, at 125; *cf.* Jeffrey A. Kelly, *Treating the Child Abuser*, *in* CHILDREN AT RISK, *supra* note 112, at 269, 269-71 (discussing approaches based on social-interactional conceptual models).

347. *See* WOLFE, *supra* note 118, at 125.

348. For discussion of such campaigns see, for example, SETH C. KALICHMAN, MANDATED REPORTING OF SUSPECTED CHILD ABUSE: ETHICS, LAW, AND POLICY 145-66 (1993); WOLFE, *supra* note 118, at 125-33; Ammerman & Hersen, *Research in Child Abuse and Neglect*, *supra* note 112, at 3, 16; Maxine R. Newman & John R. Lutzker,

These efforts, while certainly constructive, are not as effective as they might be. Recognizing the effects of evolution on the incidence of child abuse and neglect can expand and reorient our view of appropriate interventions. For example, those studies that attribute the special difficulties stepfamilies encounter to "role confusion" lead to arguments that "[s]trengthening the role of the ambiguous stepparent" would eliminate stresses, reduce child abuse, and "provide more protection for children,"[349] and that "institutionalized standards for conduct in reconstituted families are likely to emerge" as divorce and remarriage become more common.[350] In contrast, an evolutionary analysis suggests that stepparents may be finding their roles less satisfying and more conflictual than natural parents not simply because they do not *know* what they are supposed to do, but rather because they do not *want* to do what they feel obliged to do.[351] It suggests that "when people are called upon to fill parental roles toward unrelated children, we may anticipate an elevated risk of lapses of parental solicitude."[352] By expecting stepparents to feel less solicitous of unrelated children, policies can focus less on teaching stepparents how to "be" stepparents, and more on encouraging stepparents to expect, overcome, or compensate for statistically probable disinclinations.

If policymakers wanted to do something aggressive about stepparental child abuse, a whole new set of possibilities unfurl. Choosing advisable policies from among possible policies demands caution, however, because there are more ways to make a situation worse than there are to make it better. Viable alternatives will generally include pre-act strategies (rather than, for example, trial-related post-act strategies)—because evolutionary analysis can tell us very little about why a *single* individual acted as he did, even though it can tell us a great deal about patterns likely to emerge in large societies. But if we momentarily suspend our evaluative judgments, for example, possibilities for new legal and social strategies might theoretically include:

- modifying Child Protective Services report prioritization procedures to weigh stepparenthood more heavily;

Prevention Programs, *in* CHILDREN AT RISK, *supra* note 112, at 225, 228.

349. *See* Mason & Simon, *supra* note 326, at 467, 482; *see also* Giles-Sims, *supra* note 326, at 117 (explaining that lack of institutionalized stepparent roles leads to family stress).

350. Giles-Sims, *supra* note 326, at 127.

351. *See* Daly & Wilson, *Risk of Maltreatment*, *supra* note 298, at 220.

352. Daly & Wilson, *Child Abuse and Other Risks*, *supra* note 288, at 197.

- modifying Child Protective Services risk assessment patterns, upon investigation, to weigh stepparenthood more heavily;
- providing a separate legal standard for the disciplinary privilege afforded stepparents;[353]
- specially targeting parts of prevention program educative efforts toward stepparents;[354]
- reducing the number of children living with stepparents (such as with laws making divorce between biological parents more difficult);
- mandating that state agencies collect child abuse data in ways that differentiate genetic and non-genetic parents;[355]
- establishing a stronger preference for the biological parent in child custody actions;
- encouraging single parents to marry their in-laws;
- increasing deterrence (such as with legal penalties that more harshly punish unrelated abusers);
- biasing child abuse prosecutions toward stepparents;
- advising mandatory child abuse reporters (such as pediatricians) that the "information relevant to present risk" entry on their "Report Information Sheet"[356] should include any non-genetic relationship between adult and child.

It is clear that the spectrum of *possible* legal strategies informed by evolutionary analysis can range from the most restrictive and absurd, such as outlawing divorce, to the least restrictive and passive, such as ignoring evolutionary analysis altogether. Between will often lie plausible and achievable strategies that, combined with other efforts, may significantly improve a society's ability to achieve its established goals. The purpose here is not to develop or examine advisable legal strategies, but simply to demonstrate how useful

353. Parents are specially privileged by both statutory and common law to use corporal force upon their children (so long as it is not unreasonable, pursuant to an improper purpose, or unduly damaging). A stepparent generally is entitled to the same disciplinary privilege as a parent. *See, e.g.*, Natural Mother v. Hinds County Welfare Dep't, 579 So. 2d 1269, 1270-71 (Miss. 1991); MARGARET M. MAHONEY, STEPFAMILIES AND THE LAW 194-99 (1994).

354. It appears that no existing programs specifically target stepparents. *See* UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 164 tbl.5.1 (citing D.P. MUELLER & P.S. HIGGINS, FUNDERS' GUIDE MANUAL: A GUIDE TO PREVENTION PROGRAMS IN HUMAN SERVICES, FOCUS ON CHILDREN AND ADOLESCENTS (1988)).

355. The Report of Suspected Child Abuse Neglect for the Connecticut Department of Social Services, for example, asks for the name of the suspected perpetrator, but not the relationship of the perpetrator to the child. *See* KALICHMAN, *supra* note 348, at 133.

356. *Id.* at 128.

evolutionary analysis can be in helping to identify new ones.[357] Many of these strategies might never be considered absent the more holistic perspective evolutionary analysis encourages.

3. How Can Evolutionary Analysis Help To Improve Cost-Benefit Analyses?

A legal system often must ascribe relative values to independently laudable goals and make trade-offs between them. Pursuing any goal zealously may compromise another. Individual justice, for example, trades against administrative simplicity, and many things of social value trade against the amount of money necessary to secure them. The key to rationalizing this process is the ability to make informed (though rarely precisely quantifiable) cost-benefit analyses.

The third of four applications of evolutionary analysis, then, involves increasing the precision of the cost-benefit analyses that help society select and prioritize legal goals. Evolutionary analysis can accomplish this in two ways. First, it helps identify potential conflicts between goals. Many conflicts are already patent. Curbing sexual harassment in the workplace may require some encroachment upon generally prized autonomy in dating behavior, for example. Known conflicts make trade-offs more obvious, and enable informed decisions about which goal takes precedence, and under what circumstances. Yet other conflicts between policies are often deceptively latent. These hidden conflicts impede legal regimes, as surely as efforts to drain a pool at one end, and to fill it at the other. Evolutionary analysis provides a powerful tool for exposing such hidden conflicts. By enabling us more clearly to see the inter-connectedness of different kinds of human behavior, it often reveals hidden tensions between two policies.

Second, evolutionary analysis increases the comprehensiveness of each cost-benefit calculus by providing some sense of what the costs of the tensions actually are. For example, it can help define the effect upon the pursuit of one goal of more zealous pursuit of another. Although evolutionary analysis generally says little about which goal society should favor,[358] it can highlight previously uncon-

357. Several of these approaches are explored in BECKSTROM, DARWINISM APPLIED, *supra* note 3; and BECKSTROM, SOCIOBIOLOGY AND THE LAW, *supra* note 3.

358. One possible exception: When an existing goal rests heavily on an assumption that biology reveals to be overstated or otherwise incorrect, as a matter of fact, the rationale supporting the goal might be weakened. This would not require that the goal be changed, but it would probably recommend reexamination, and perhaps alternative articulation, of the basis for the goal.

sidered costs of social and legal policies. Exposing and loosely quantifying conflicts therefore increases the accuracy of the cost-benefit analyses by which known conflicts are resolved.

Three simple examples will suffice to illustrate the power of identifying potential conflicts between goals and improving cost-benefit analyses. Consider the following: Primary responsibility for investigating reports of child abuse currently falls to state child protective services (CPS) agencies.[359] Because they are typically overburdened,[360] they often fail to make timely investigation of reports of child abuse.[361] Such a circumstance makes critical the precise criteria by which CPS workers organize risk factors to prioritize reports for investigation.[362] While little is known about how CPS agencies prioritize reports,[363] it is generally known that the presence of a stepparent in a home where child abuse is suspected does not affect CPS decisions.[364] At the same time, the number of children

359. *See* UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 268. For more on the operation of CPS agencies, see KALICHMAN, *supra* note 348, at 134-40; KRAMER, *supra* note 113, at 73-79.

360. For many, case loads are two to three times beyond manageable levels. *See* CRITICAL FIRST STEPS, *supra* note 138, at 73.

361. *See* UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 268. It is common for agencies to operate in violation of legislatively mandated maximum response times. *See* CHILD WELFARE LEAGUE OF AM., TOO YOUNG TO RUN: THE STATUS OF CHILD ABUSE IN AMERICA 5, 6 (1986) [hereinafter TOO YOUNG TO RUN]; CRITICAL FIRST STEPS, *supra* note 138, at 34-35 (noting that as many as one-third of state CPS agencies do not routinely investigate within legally prescribed time); KALICHMAN, *supra* note 348, at 133; UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 268. In New York City, for example, one study found that 10% of reported child abuse went uninvestigated for 40 days or more. *See* Douglas J. Besharov, *Unfounded Allegations: A New Child Abuse Problem*, 83 PUB. INTEREST 18, 24 (1986). Although for a long time child abuse reporting increased far faster than CPS budgets, *see* NATIONAL CTR. ON CHILD ABUSE PREVENTION RESEARCH, NATIONAL COMM'N FOR PREVENTION OF CHILD ABUSE, CURRENT TRENDS IN CHILD ABUSE REPORTING AND FATALITIES: THE RESULTS OF THE 1992 ANNUAL FIFTY STATE SURVEY 20-21 (1993); 1990 SURVEY, *supra* note 114, at 1. Congress in 1993 provided all states with new funding for child welfare intervention and prevention services. *See* CURRENT TRENDS IN CHILD ABUSE REPORTING AND FATALITIES, *supra* note 113, at 17. Over time, this may improve the timeliness of investigations.

362. *Cf.* TOO YOUNG TO RUN, *supra* note 361, at 5-6 (describing the factors agencies consider when prioritizing investigations and the problems with such priorities). The agencies "often lack consistent criteria to help workers to make informed judgments in their investigations of reported or suspected child maltreatment." UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 269.

363. *See* DEAN D. KNUDSEN, CHILD PROTECTIVE SERVICES: DISCRETION, DECISIONS, DILEMMAS 53-67 (1988) (reporting on what little is known about CPS worker decisions to investigate reported abuse); UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 268-69.

364. *See* MAHONEY, *supra* note 353, at 192-93:

who will live with a stepparent is increasing dramatically.[365] Evolutionary analysis suggests that, if the agency were to ascribe more weight to the presence of a stepparent, say by modifying its standard operating procedures to preferentially investigate reports of child abuse in homes with substitute parents, children would be better protected.

Still, pursuing such a plan would immediately put two important goals into tension. On one hand, governments want to eliminate child abuse. On the other hand, they want to avoid stigmatizing entire groups on the basis of the transgressions of the few.[366] Indeed, it appears that the legal trend is to argue for and actively expand the rights of stepparents (with respect to custody and visitation disputes, for example) in an effort to bring them into parity with biological parents and to combat what are perceived as historical and unjust prejudices against them.[367] Finally, many commentators argue that "we should take great care not to stigmatize stepfamilies."[368] Evolutionary analysis therefore forces recognition that the costs of aggressively pursuing one goal, such as the prevention of child abuse, must often be defined, in part, in terms of interfering with pursuit of

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As a general rule, the decisions made by child protection agencies are not affected by the fact that the child resides in a stepfamily. Furthermore, the focus of many state neglect and abuse laws is on the family or household in which the child resides, without regard to the particular composition of the household.

365. The number of stepfamily households increased 36% during the 1980s. *See* MARRIAGE, DIVORCE, AND REMARRIAGE, *supra* note 309, at tbl.L. In 1990, at least 7,000,000 children lived with stepparents, whose marriages had grown to represent 20% of all married-couple households with children. *See id.* at tbls.L & N. Some predict that soon as many as one child in three, perhaps even one child in two, will spend some childhood years in a stepfamily. *See* Paul C. Glick, *Remarried Families, Stepfamilies, and Stepchildren: A Brief Demographic Profile*, 38 FAM. REL. 24, 26 (1989) (predicting one in three, or one in two); *see also* Frank F. Furstenberg, Jr., *The New Extended Family: The Experience of Parents and Children After Remarriage*, *in* REMARRIAGE AND STEPPARENTING, *supra* note 324, at 42, 44 (predicting one in four).

366. On negative images associated with stepparentage, see BRENDA MADDOX, THE HALF-PARENT: LIVING WITH OTHER PEOPLE'S CHILDREN 32-37 (1975) and sources cited *supra* note 343.

367. *See, e.g.*, Gilbert A. Holmes, *The Tie That Binds: The Constitutional Right of Children to Maintain Relationships with Parent-Like Individuals*, 53 MD. L. REV. 358, 410 (1994) (arguing the law should "grant[] parent-like individuals greater consideration than the current jurisprudence affords"); Carol Lynn Tebben, *An Expansion of Stepparent Rights? The Equitable Parent Doctrine After* Atkinson, 6 AM. J. FAM. L. 43, 53 (1992) (arguing for "significant legislative reforms in the recognition of stepparent rights" in order to combat "[i]njustices . . . still occur[ring] in the courts"); *see also* MAHONEY, *supra* note 353 (providing comprehensive overview of trends in legal status of stepparents).

368. Furstenberg, *supra* note 365, at 42, 57; *accord* Coleman, *supra* note 319, at 30; Daniel S. Halperin, *Risk Factors for Child Abuse and Neglect in Human Parents*, *in* MOTHERHOOD, *supra* note 162, at 125, 131; Mason & Simon, *supra* note 326, at 481.

the other, such as the expansion of stepparent rights. Thus, either one cost of reducing child abuse is in stigmatizing stepparents, or the cost of *not* stigmatizing stepparents is some number of otherwise preventable child abuse incidents (even infanticides), on the other.

As another example, one can anticipate that, because natural selection has long favored animals with sensitivities to potential costs and benefits of parental investment, recent efforts by some states to impose on stepparents the same financial obligations for child support that a biological parent endures might increase child abuse in some fraction of the substitute parents—by effectively and significantly raising the costs, to them, of each stepchild.[369] Indeed, evolutionary analysis will align with economic analysis to predict that such new obligations, if enforced, might even create disincentives to marry persons with dependent children.[370] While scholars arguing for increased stepparental obligations and rights may be motivated, in part, by the no doubt accurate perception that such legal intervention will improve the lot of some children and some stepparents,[371] the

369. In most states, stepparents are not required to provide for the stepchild's support during or after marriage. *See* MAHONEY, *supra* note 353, at 13; Margaret M. Mahoney, *Support and Custody Aspects of the Stepparent-Child Relationship*, 70 CORNELL L. REV. 38, 41-45 (1984) [hereinafter Mahoney, *Support and Custody Aspects*]. Missouri, however, mandates that: "[a] stepparent shall support his or her stepchild to the same extent that a natural or adoptive parent is required to support his or her child so long as the stepchild is living in the same home as the stepparent." MO. REV. STAT. § 453.400 (1986); *see also* MAHONEY, *supra* note 353, at 7 n.24, 39 & n.78 (noting several other state statutes with similar effects).

370. This will be true, so long as the demand for marriage is not perfectly inelastic. Some have argued that newly imposed financial obligations are unlikely to create significant disincentives to marry because marriage decisions involve more than economic factors, and because marriage is already common even *with* the financial obligations one incurs for one's spouse. *See, e.g.*, Mahoney, *Support and Custody Aspects, supra* note 369, at 46-48.

An analysis informed by evolutionary psychology, however, makes clear that an attraction to potential mates and a disinclination to cater to unrelated juveniles are *both* likely to be strongly developed in animals because a mate can potentially contribute directly to reproductive success while an unrelated juvenile never can. Nonetheless, new obligations may create few disincentives in any event because states quite rarely enforce them—even against genetic parents. Personal Communication with Professor Ira Ellman, Professor of Law, Arizona State University College of Law, in Tempe, Ariz. (Mar. 12, 1996).

371. *See, e.g.*, David R. Fine & Mark A. Fine, *Learning from Social Sciences: A Model for Reformation of the Laws Affecting Stepfamilies*, 97 DICK. L. REV. 49, 75-80 (1992) (arguing for liberalization of law's treatment of stepparents); Mahoney, *Support and Custody Aspects, supra* note 369, at 41, 78 (arguing for "assigning stepparents greater duties during marriage . . . [and] balancing concurrent stepparent and natural parent obligations," and that "[l]aws requiring the stepparent to share the child support duty of his or her spouse during marriage would better accommodate the financial interests of family members"); Mason & Simon, *supra* note 326, at 450 (arguing that "children will benefit

other side of this equation cannot be ignored. It should affect analysis, even should it prove non-dispositive.

As a final example, evolutionary analysis exposes as predictable a rise in child abuse and infanticide as a consequence of anti-abortion and anti-contraception policies. This phenomenon is evident in countries like Brazil, where recent and widespread conversion to Catholicism has in some places rendered the use of contraception and abortion procedures somehow more sinful than pre-existing infanticidal practices.[372] Incidents of the latter have increased as those of the former have decreased.

Consequently, evolutionary analysis can starkly reveal significant subsurface tensions between policies that previously seemed to coexist peacefully. Although it provides little guidance, if any, as to which policy should be primary, it does help to expose, and at some rough level to quantify, previously hidden costs in the aggressive pursuit of one or the other.

4. How Can Evolutionary Analysis Help To Reveal Promising Directions for Future Research?

A fourth useful application of evolutionary analysis is to point out promising, law-relevant directions for future research. First, as mentioned earlier, evolutionary theories can suggest the search for hidden patterns unpredicted by prevailing theories.[373] For example, while recent recommendations on future child abuse research emphasize only "the importance of knowing more about the backgrounds and experiences of developing children and their families, within a broader social context that includes their friends, neighborhoods, and communities,"[374] evolutionary analysis suggests the utility of greater research emphasis on understanding the processes by which generally adaptive behaviors may contribute to the incidence of child abuse.

Second, the process of critically evaluating the applicability of

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from having more responsible adults in their lives rather than fewer," and that a federal initiative increasing stepparent obligations would promote child welfare); Michael J. Markoff, Note, *Stepfamily Law: Review and Proposals for Change*, 18 SUFFOLK U. L. REV. 701, 714-20 (1984) (arguing for expansion of stepchild rights to post-divorce support, inheritance by intestate succession, and recovery for the wrongful death of a stepparent).

372. *See* PIERS, *supra* note 221, at 15-16; vom Saal, *supra* note 221, at 62-64.

373. This is, for example, one of the profound benefits of Daly and Wilson's work on stepparents, which for the first time argued convincingly for the separate collection of data on genetic parents and stepparents.

374. UNDERSTANDING CHILD ABUSE AND NEGLECT, *supra* note 112, at 4, 49-52.

evolutionary theories in the human context, explored in *The Information Stage*, will often generate a need for further research when more than one evolutionary theory purports to explain various aspects of human behavior.[375] For example, one might collect further data to attempt to distinguish the relative importance of the *DPS Theory* and the *Reproductive Access Theory* in the context of stepfather abuse.

Third, the process of attempting to integrate robust evolutionary theories with prevailing theories, explored in *The Integration Stage*, may generate researchable questions where true conflicts may exist between the predictions of evolutionary and prevailing theories. By helping to identify each of these research agendas, evolutionary analysis encourages improvement in the behavioral models on which all law is based.

CONCLUSION

Law deals in human behavior. Every legal regime therefore inescapably reflects some behavioral model purporting to draw causal arrows between supposed influences and law-relevant behavior. In a very real sense, the model defines and limits the targets and tools of legal policies. The power of the model limits the power of law.

Of course, few components, if any, of our decentralized national, state, and local legal systems could accurately be said to reflect a single behavioral model consciously chosen, and well-defined. To date, little has suggested that this is necessary or plausible. Nonetheless, common features of operative behavioral models do emerge. One of these is a preoccupation with the immediate causes of human behavior, to the exclusion of evolutionary causes of human behavior. This all too easily lends itself to the presupposition that the influence of human mind on behavior means that all human behavior (at least all truly significant, law-relevant human behavior) comes from mind—a mind socially and individually constructed by the summed experiences and encounters of each human lifetime.

Behavioral models that overemphasize immediate causation are not so much wrong as they are importantly incomplete—continuing to obsolesce at the quickened pace of behavioral sciences. Evolutionary analysis restores holistic balance and comprehensiveness to the study of causation, making clear that human behavior, like all animal behavior, follows from two very different kinds of causes—proximate and ultimate—that operate simultaneously. Failing to ac-

375. *See supra* Part II.B.3.

commodate this uncontroversial aspect of modern science means foregoing opportunities to increase law's effectiveness and can also lead to legal realities that are out of touch with the way human behavior actually operates.

The inevitable potential for misunderstanding or misusing biology indisputably warrants constant vigilance, careful empirical studies, and regular reflection.[376] But it similarly warrants good faith efforts at self-education. Because proper evolutionary analysis is probabilistic, not deterministic, it can help us better understand human behavior by illuminating its historical context, highlighting its dynamic processes, providing insights into its origins, and suggesting circumstances that are more likely to evoke certain behavioral responses than others. Properly used and qualified, evolutionary analysis in law can refine behavioral models that identify risk factors for behaviors, help generate new legal strategies to pursue prearticulated and socially defined goals, improve cost-benefit analyses of potential legal policies, and reveal promising new directions for future research.

376. Here I am in full agreement with Professors Dreyfuss and Nelkin that we should not assume that insights from biology *require* alteration of such concepts as "personhood, normalcy, responsibility, and culpability that are fundamental to the law." Dreyfuss & Nelkin, *supra* note 13, at 348. On the other hand, the law needs a rigorous theory of normality in order to have a rigorous theory of abnormality, and evolutionary biology can provide powerful insights into the origins of species-typical behaviors.